MODERN TECHNOLOGY AND CIVILIZATION

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MODERN TECHNOLOGY AND CIVILIZATION

AN INTRODUCTION TO
HUMAN PROBLEMS IN THE MACHINE AGE

MODERN
TECHNOLOGY

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AND CIVILIZATION

AN INTRODUCTION TO
HUMAN PROBLEMS IN THE MACHINE AGE

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MODERN TECHNOLOGY AND CIVILIZATION

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PREFACE

Most of us are both disturbed and exhilarated by such technological revolutions as nuclear energy, space travel, and automation. This book is designed for all persons who want to explore both the human problems and the promises of the machine age in which we live.

Each section theme has an introductory discussion by the author. The general reader may wish to read these straight through—they form the "plot" of the book—with only an occasional reference to the selections. For college classes the entire book is designed as a text for courses on modern technology and civilization. When so used, sections may be assigned and the theme of each supplemented by lectures and by collateral reading. Or this book may be used as a supplementary text or source book for courses in the history of technology or the history of science, and also for certain courses in the social sciences. It may be used to supplement other texts in the study of the individual firm, and for courses in industrial sociology and industrial psychology.

For students in business and engineering schools it is designed for a short—or a long—orientation course designed to show, through detailed case material and discussion, the relation between the student's future profession and the kind of society in which he will live. For such students the book provides material for both the analysis of practical problems and the discussion of larger social issues in the field of machine-man relationships.

Charles R. Walker

ACKNOWLEDGMENTS

For the ideas which have gone into this book, the author is indebted to a very large number of persons. To the scholars who have permitted selections to be printed here from their work, he is most grateful, and also for the helpful suggestions from many of them which went into the over-all shaping of the book. For direct assistance and encouragement he is heavily indebted to his colleagues on the Technology Project of Yale University and to the Project staff. For ideas and criticisms over the years he is grateful especially to E. Wight Bakke, Franklin Baumer, Lloyd Reynolds, John Dollard, Neil Chamberlain, and Chris Argyris of Yale University; to George Homans of Harvard University and to Fritz Roethlisberger of the Harvard University Business School; to Charles Myers, Douglas McGregor, and Warren Bennis of MIT; and to Rensis Likert and Floyd Mann of the University of Michigan. Arthur Turner, a former Yale colleague now at the Harvard Business School, was kind enough to read critically the manuscript before publication. He is responsible for many improvements, but not for errors of commission or omission that may remain.

Many on the staff of the Technology Project have patiently worked with the author through the many stages of manuscript preparation. I am especially indebted to Emily Moore, Ellen Brainard, Ella Gibson, and my former secretary, Anne Murray. I am grateful for invaluable editorial assistance and advice both from Mrs. Murray and from Victoria Suddard of the Human Relations Area Files.

My wife, whose name appears modestly on the title page as my "assistant," is responsible for launching the author on the enterprise, for getting the book underway in its early stages, and for doing the basic research and writing on the section Technology in Non-Western Countries.

BIBLIOGRAPHICAL NOTE

The selections and bibliographical references in this book are drawn largely from books or journals published in the United States or in the United Kingdom. A few translations and references have been made from the work of a group of French scholars who, for many years, have concentrated in this field. Scholarly research into the social effects of technology has been growing in other European countries, and it was the author's original intention to include translations from the most important publications in this field for all countries, as well as bibliographical references. Lack of both time and space has compelled the postponement of this enterprise till a later date. Meantime, the interested reader is referred to the excellent bibliographies on this and related subjects for most countries in the world, published by the International Social Science Council, UNESCO House, Annex, 6 Rue Franklin, Paris VII. Especially useful for Europe is the one prepared for the Conference on the Social Implications of Industrialization and Technological Change, held in Chicago, September 15 to 22, 1960. It is entitled "Working Paper No. 11, Research Survey of the Social Implications of Industrialization in Western and Southern Europe," and is by Sjoerd Groenman of the University of Utrecht.

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GENERAL INTRODUCTION

In the past two or three decades, Man has begun to focus the social sciences on the relationship between Man and his creature, the Machine. This book is concerned with that relationship.

The book is divided into four parts. The first puts technology into the perspectives of time, space, and history. The second looks at the problems and promises of technology in our own day, in the West, where industrialism and industrial civilization first originated and where, up to now, they have reached their highest development. The third part looks at technology in non-Western countries. This theme might easily absorb the whole volume, for central to the fate of civilization is the story now unfolding of the conquest by the Machine of China, India, Africa, and other parts of the non-Western world. The fourth and final part looks at the unprecedented human problems and opportunities posed by modern technology and how to think about them. A few years ago, the author wrote:

> Rapid change has now left most Americans a little breathless. So complex are effects of changing technology that they have overtaken mankind as problems rather than as opportunities. If men are to utilize technology for the good life, they will have to find a substitute for time, which in the past permitted the human organism, and the community, to adjust to the pace of history.

This book will suggest at least two substitutes for time: (1) systematic knowledge of human behavior under the impact of technological change and (2) an assumption of responsibility by all parties at interest for the problems as well as the benefits of industrial progress.

Modern technology and civilization are obviously a subject of tremendous scope and one which might be treated in a hundred ways. It is important, therefore, at the beginning to define the limitations of this book and the author's criteria for including themes and material. First, the book is limited to modern technology, not medieval, ancient, or primitive. Even when historical backgrounds are touched on, they are looked at in order to put contemporary technology into perspective, rather than for their own sake.

The second limitation is an emphasis on technology in industry—and through industry on industrial man in his new and rapidly changing civilization. Modern man is assuredly organizational man, and organizations today in a hundred ways are dependent on technology—conceived as utilities, machines, techniques, and sources of power. It is largely through organizations that technology influences modern man and modifies his ways of working or thinking or living. A major theme of the book, therefore, is the way in which technology remolds organizations, and through them the lives of men and women.

Since it would be impossible in less than a dozen volumes to look at the way technology influences *all* organizations, the emphasis will be on industrial ones. But besides economies in space there is another justification for this emphasis and limitation. Most students of modern society are agreed on the special importance of organized industry, not only as a nexus of extraordinary economic powers, but as a normative influence on other types of organization in the modern world. Governmental, labor, military, to name but three, exhibit some of the organizational features of large industrial organizations. As to technology, whatever form human organization takes, it is here argued that the technological component is fundamental. Without keeping the technological component in mind, organizational thinking occurs in a theoretical vacuum.

But why technology and *civilization* for a book with this scope and these limitations? Why not, it might be asked, technology and, say, modern society? For this reason: The word "civilization" suggests a linking of the material presented here not only to social structure but to human values, past and present. It is the assumption of the book that the future of all civilizations is closely linked to the way man uses or misuses the powerful instruments of modern technology. Briefly, the central theme may be stated as *ways in which modern technology through industry affects people, organizations, and values.*

What Is Technology?

As used in all sections of this book, technology includes both physical objects and the techniques associated with them. For instance, the technology of pottery making includes (1) the clay or other materials, (2) the potter's wheel or other machinery, and (3) all the skills and procedures that enter into making the product. Similarly, when this book speaks of the technology of an automobile assembly line, there is signified not only the moving conveyor and all other "hardware," but also the mass-production methods devised by management and practiced by workers to assemble an automobile. In such a definition, scientific management and other kinds of engineering rules which impinge on people are included under the term "technology."

One approach to the subject is to look at technology as having an *outer* and an *inner* aspect. To illustrate: Modern technology may be perceived as an *environment* within which we live, made up of external and tangible things which we modify from time to time and which modify us. Examples: The subway taking a man to work is a fragment of that environment, the drop forge in a factory, indeed all machines and utilities in all factories are part of this external environment. So, too, is an operating room, a television set, and a guided missile. Modern technology can also be viewed internally. In this sense it consists of skills of body and brain, of technical and administrative procedures, and of mental processes, both conscious and unconscious, some of them associated with value judgments which relate man's outer world to his inner one. We shall be concerned in our discussions and selections with both the outer and the inner aspects of technology.

Criteria

It has already been said that this book will study the ways in which technology affects men and organizations in the powerful world of modern industry. Emphatically, the impact of technology poses both problems and opportunities for industrial man and for contemporary civilization. Introductory discussions and the selections will illustrate as concretely and vividly as possible *both* (1) the concrete phenomena (the actual changes, good and bad, caused by technological development) and (2) the choices for thought and action emerging from them. These two types of material will appear in all but the final part, and they dictate the general criteria for the choice of selections.

The first type demands either case material or research by competent observers, and, when possible, competent participant observers in strategic socio-technical situations. Such situations may be defined as the more important points of intersection between technology, persons, and organizations.

The second type calls for comment and discussion by persons distinguished either as experienced practitioners in the field of socio-technical relations or as good analysts and diagnosticians of empirical data. Much of the material selected for this type of study is frankly pragmatic, or of a low order of abstraction. The reason for this is twofold. First, the need is urgent for *any* material helpful in the solution of economic and social problems that involve men, machines, and organizations, and for that reason diagnostic material believed to be useful for the active practitioner has been included. Second, the field is so new that conceptualization is newer still and far from adequate.

To partially supply this latter deficiency, an effort has been made in the last part to discuss the relation of empirical data and diagnostic material to social science theory. This has been done both in the introductory essay to that part and in the subsequent selections. Finally, the author makes a brief appraisal of the themes and material of the book in the light of the values of Western civilization.

It should be added that the book as a whole aims at presenting relevant materials for an introduction to the human problems of our technological age rather than relating them to a finished system of conceptualization. (The author hopes in subsequent writing to make progress toward the latter goal.)[1]

These limitations and criteria may be illustrated and clarified by looking section by section at Part Two, Problems and Promise of the Machine Age. This is the longest division in the book. It opens with Section A, The Machine Age: A prologue, which discusses six major discoveries or advances in technology and then illustrates strategic ways in which each transforms the life of modern man. The selection, a classic discussion of this theme by a distinguished authority, paints the subject in broad strokes and yet does so by reference to concrete examples.

Section B, Mass Production and Scientific Management, deals with the two great organizing techniques which were used—and are still being used—to link the great discoveries in modern technology to men and machines, to organizations, and to the economic system.

Section C, Revolution in the Machine-Man Relationship, has a far sharper focus than either section A or B. It looks at modern technology in its most immediate thrust at working men and women when they are directly subject to the controls or influence of machines. This section supplies empirical data and suggests approaches to the solution of practical problems especially at worker-supervisor levels.

Section D, Men, Machines, and Organizations: A Reappraisal, expands the field of inquiry to include technological influence and effects at all levels of an industrial organization and on the organization as a whole. It discusses automation and reviews some recent research which makes possible a reappraisal of earlier approaches to the relations between men, machines, and organizations.

Section E, Money and Motivation in the Machine Age, turns to the relation of the new technologies to financial rewards and to the psychology of men and women at work. Again, both empirical and diagnostic material is included.

As suggested earlier, possibly the most striking characteristic of modern technology, in contrast to earlier ages, is its dynamism or the acceleration in its rate of change. "In the past, human life was lived in a bullock cart, in the future it will be lived in an aeroplane; and the change of speed amounts to a difference in quality," wrote Alfred North Whitehead. Substitute rocket or guided missile for airplane and the comment is acutely applicable.

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[1] Even with the limitations and the narrowing objectives given, the author is acutely aware of many appropriate topics and much illustrative material he *might* have chosen. By references in the text and through the bibliography, he hopes to have atoned in part for his omissions.

Section F, Technology and Change, discusses not only the "change in quality" of our time over any other, but also, by way of case material, the practical problems which major and minor technological changes pose for both leaders and followers in modern industry.

A word on Part Three: However rapid the technological changes and their social consequences in the industrial West, they are occurring even more rapidly—and with more explosive consequences—in non-Western countries. The so-called "underdeveloped" areas of the world are determined to remain so no longer, and with or without our help the advance of modern technology is becoming global. Part Three, Technology in Non-Western Countries, presents basic problems which modern technology is posing for all countries now in transition from a primitive agricultural to an advanced industrial economy.

For one who chooses selections for a book of this order, there is always the question of how old or "classic" or how new and pioneering the selections should be. The old may be dated, or if suitable, so readily available as not to justify reprinting. The new may fall into the category of overspeculative, or of merely intellectually fashionable, and so not merit reprinting till an aging process has occurred. In the last analysis, any editor-author must rely on his own judgment; here in doing so the author has attempted to follow this rule: He has chosen from older material only such as seemed essential to background understanding and to continuity of presentation, and from the newer material, what seemed to provide the most intelligent and meaningful connection between the present and the future. To take a few examples, he has reprinted Henry Ford's article on mass production, a chapter from Taylor's Principles of scientific management and Elton Mayo's classic on repetitive work. As examples of new material, the reader will find a recent research study of the human problems of engineers in an advanced science-based industry, Charles Frankel's speculations on the frontier between present and future technologies, and Sir Julian Huxley's speculations on the future of man.

It is hoped that the material cited of successful—and unsuccessful—relationships between technical imperatives and human needs—in short, between the Machine and Man—will prepare the reader for Part Four, How to Think about It: Technology and Human Values. Here both the introductory discussion and the selections stress the second term in the title of our whole inquiry—"civilization"—and among other questions, these are asked:

How can psychology, sociology, economics, and the other social sciences be so related to engineering and to the physical sciences as to help solve what Elton Mayo called the "human problems of an industrial civilization"?

Finally: Must men rely on instinct, or common sense, or the market, as they have been doing in the past, to control the development and use of applied science in the modern world, or are there other ways of guiding the flow and molding the influence of technology in the interest of "the good life"?

PART ONE

PERSPECTIVES: TIME, SPACE, AND HISTORY

INTRODUCTION

As the relatively new sciences of anthropology and archeology have developed, the great importance of technology has been demonstrated not only for modern man but for man throughout the whole period of his life on the planet. To begin with one example: Of the discovery and use of fire, the first great technological revolution, Carleton Coon, the anthropologist writes: [1]

> The use of fire is the only open-and-shut difference between man and all other animals. Fire was the first source of power which man found out how to use which did not come from the conversion of food and air into energy inside his own body. Fire made him a more efficient animal, and during the last eight thousand years he has found increasing uses for it, and burned ever greater quantities of fuel. Fire has been the key to his rapid rise in mastering the forces of nature, his conquest and partial destruction of the earth, and his current problems.

Of nonliterate man who possessed our earth for many thousands of years before the coming of civilization, Melville Herskovitz comments:

> The picture of non-literate man we draw from studying his technology and material culture is of a hard-working individual who effectively calls on the skills that he has learned, and that are adequate to gain him the living he desires. . . . By means of their technology, men wrest from their habitat the foodstuffs, the shelter, the clothing, and the implements, they must have if they are to *survive*. . . . (Italic added.)

The evidence suggests that technology has always been essential to human existence and progress, both before and after the dawn of history. But the time dimension emphasizes another fact of great significance, the incredible slowness in technological progress in all the early stages of man's development, and the astonishing acceleration in the rate of that development in later stages.

Anthropologists are not able to agree on the date for the first coming of Man on the earth, but the range generally accepted is between a quarter of a million and a million years ago.[2] If the first estimate, 250,000 years, is taken and reduced to the scale of one hour, some sense of the relative time spent on the several phases of technical progress can be attained.

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[1] Carleton S. Coon, *A Reader in General Anthropology*, Holt, Rinehart and Winston, Inc., New York, 1948, pp. 62–63. As to when fire was first "discovered," according to Kenneth Oakley, earliest use of fire by man occurred in the Far East, between 300,000 and 400,000 years ago; in Europe, 250,000 years ago; and in Asia and Africa, 100,000 years ago. See Kenneth Oakley, "Fire as Paleolithic Tool and Weapon," *Proceedings of the Prehistoric Society for 1955*, p. 36.

Making the scale an even 240,000 for mathematical convenience, man then spent 55 minutes, or 11/12 of the whole period in the paleolithic (Old Stone) culture.[3]

> Five minutes ago, he embarked upon the neolithic culture, the cultivation of plants, the domestication of animals, the making of pottery, weaving, and the use of the bow and arrow; 3½ minutes ago he began the working of copper; 2½ minutes ago he began to mold bronze; 2 minutes ago he learned to smelt iron; ¼ of a minute ago he learned printing; 5 seconds ago the Industrial Revolution began; 3⅓ seconds ago he learned to apply electricity; and the time he has had automobiles is less than the intervals between the ticks of a watch, i.e., less than one second.

The significance of this time perspective is not to flatter modern man by showing how much more rapidly he has developed than his ancestors, but to suggest, rather, that the machine age, and, indeed, the whole age of science and technology, is still very very young; young, that is, within the time span of human life on earth. If our civilization is youthful, then it it presumably characterized by both folly and promise.

Sir Julian Huxley clearly had this point in mind when he wrote: [4]

> The psychosocial phase of evolution is thus in its infancy: man, as dominant evolutionary type is absurdly young. I may adapt a simile of Sir James Jeans: If you represent the biological past by the height of St. Paul's cathedral, then the time since the beginning of agriculture and settled life equals one postage stamp flat on its top. And, unless man destroys himself by nuclear war or other follies, he can look forward to evolving through at the least the time equivalent of another St. Paul's.

Of equal importance with time for giving perspective to technologies past and present is the dimension of space. Prehistoric Man with his technologies possessed, it is to be inferred, only a few favored spots on the earth's surface. Today, although the situation is altering rapidly, Industrial Man still has not fully possessed the habitable globe. The dimension space, then, is suggestive, indeed indispensable, for any study of modern technology and its influences. In the field of astrophysics, the spatial dimensions of the universe have been expanding at a staggering pace. Space technology has now enabled men to enter interplanetary space for the first time. But even taking an earth-bound look, the dimension of global space has been vastly expanded by the modern technologies of communication and transportation and also by the rapid spread of every variety of industrial technology to more and more areas of the earth's surface. The incredibly rapid industrialization of the Soviet Union by the aid of technology is one of the miracles of the twentieth century. Perhaps it is only necessary to mention India, the Middle East, Red China, and Africa to suggest the growing importance of spatial expansion of industrial technology to the modern world.

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[2] Frederick E. Zeuner, "The Chronology of Early Man and his Cultures," *Dating the Past,* Methuen & Co., Ltd., London, 1958.

[3] Wilson D. Wallis, *Culture and Progress,* McGraw-Hill Book Company, Inc., New York, 1930, p. 99.

[4] Julian Huxley, "The Future of Man," *Bulletin of the Atomic Scientists,* vol. 15, no. 10, December, 1959.

Time and Space and their relation to the development of Industrial Man are given particular illustration by the selections in this part. (But they are very useful dimensions to keep in mind throughout the book.)

Two striking features are related to both dimensions. The first is the *acceleration* in growth of the variety and volume of modern technology. The second is the *range* of influence of the new technologies in transforming every aspect of modern life. "In an important sense," writes Robert Oppenheimer, "this world of ours is a new world, in which the unity of knowledge, the nature of human communities, the order of societies, the order of ideas, the very notions of society and culture have changed and will not return to what they have been in the past."

There are, of course, elements other than science and technology which make up a society or a civilization, and the relative influence of each is not easy to weigh or measure. The political system is one of these elements, religious beliefs are another, and the "mores" which relate marriage, sex, and family are a third. In attempting to classify such components of the major culture systems in Man's history, the Human Relations Area Files[5] have arrived at a number of basic categories. But from age to age, and between one nation or one culture system and another, it is obvious that there have been immense variations. First one culture component like war, or religion, appears preeminent in influence, then another or a combination of components. We shall argue in this book that in our own time, Science and its lusty offspring Technology are more vigorous and dynamic than in any previous age or culture system. Put another way and perhaps more accurately, Science and Technology have given our age more of its unique characteristics and coloring than they have any other age. They have done so by altering nearly all the basic components which make up the life of modern man, and altering them in important ways. It might also be said that our civilization is unique in that compared with others, technology offers a greater potential for either progress or annihilation.

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[5] The Human Relations Area Files is a system for organizing materials and for information retrieval for the use of scholars in sciences related to the study of man. It is sponsored by twenty-one universities and research organizations. Central office is at 421 Humphrey Street, New Haven, Connecticut.

We have discussed briefly Time and Space in broad perspective, and suggested that the reader keep them in mind in reading this book. Two new disciplines are flourishing which have begun to put both of these dimensions into a firm historical setting. They are the history of science and the history of technology. The literature in both of these fields is recommended to the interested reader, but since this volume is limited to contemporary technology and its effects, we can only illustrate briefly a few of the important ways in which the technological and scientific past lives on in the present. Out of a large and growing historical literature, selected references are given at the beginning of the section. Among them it is important to emphasize the pioneer work of Lewis Mumford in *Technics and Civilization, The Culture of Cities,* and other volumes, and the new and monumental series edited by Charles Singer and his associates, entitled *A History of Technology*. The several ways of evaluating the importance of technology to civilization are well set forth in the Epilogue to Volume II of this series, which we are reprinting as the first selection in this part.

This selection is followed by the composite of selections by Lewis Mumford to which we have given the title "Historical Origins of the Machine Age." It is accompanied by illustrative excerpts from Singer. Although some recent historians have added new approaches and material to the subject of machine-age origins, Mumford's work in *Technics and Civilization* remains the best general introduction to the subject.

That past technologies and past technological ideas live on in the present is strikingly true in the history of the machine. But there is another point—and point of view—of great importance to our inquiry which is discussed in the Mumford selections, and this is the interrelation between the cultural climate of any age and its technological achievements. Before men could turn their energies or their creative imagination to producing an "age of science" or an "age of technology," a long period of cultural preparation had to come first. "Behind all the great material inventions of the last century and a half," Mumford writes, "was not merely a long internal development of technics; there was also a *change of mind*." [Italic added.]

He then makes an even more provocative comment:

> Technics and civilization as a whole are the result of human choices and aptitudes and strivings, deliberate as well as unconscious, often irrational when apparently they are most objective and scientific; but even when they are uncontrollable, they are not external. . . . No matter how completely technics relies on the objective procedures of the sciences, it does not form an independent system, like the universe. . . . The machine itself makes no demands and holds out no promises: it is the human spirit which makes demands and keeps promises. . . .

This point touches on what we have already referred to in our criteria as the *external* and the *internal* aspects of technology. We shall reexamine it in the final part, How to Think about It: Technology and Human Values. In the meantime, many selections in this book will pose for the reader the question of whether or not certain technologies are acting as both "uncontrollable" and "external" forces. It is suggested that the reader make up his own mind before reading the last part of the book.

The group of selections called "Historical Origins of the Machine Age" begins with an analytical discussion of the question "What is a machine?" and makes important distinctions between tools, machines, and utilities. The reader is reminded of the strategic role of many technologies *other* than tools and machines; for example, houses, temples, pottery, roads and bridges. He is also reminded that certain ages which possessed high technological skills may have devoted most of them to art or religion rather than to commerce. Aesthetic materials, techniques, and skills are also technology.

The theme of a cultural climate which favors the machine is given special attention in the selection called "Ideological Preparation: The Wish before the Fact." The other selections are self-explanatory: "Time and the Machine—Authority of the Clock," "Monasteries and Mechanization," and "Leonardo da Vinci—'Compleat Technician.' "

The selections also illustrate the two dimensions discussed earlier, Time and Space. Between 1400 and 1700 the swelling stream of scientific and technological development was profoundly influenced and accelerated by both dimensions. Time ceased to be associated with organic or natural changes such as waking and sleeping or, in nature, sunrise and sundown, and was transformed into a mathematical—and hence divisible—entity created by the clock. This point is elaborated in "Time and the Machine—Authority of the Clock," but its full significance for modern men cannot be understood without uniting the concept of mathematical time with the concept of mathematically measured space. Both grew in the fifteenth and sixteenth centuries and together produced wholly new ideas about motion and locomotion. "The new attitude toward time and space infected the workshop and the counting house, the army and the city," Mumford writes. "The tempo became faster; the magnitudes became greater; conceptually, modern culture launched itself into space and gave itself over to movement."

The last quotation suggests a question as we move closer to modern times: What is the relation between technology and modern industrialism? Did modern technology create modern industrialism, or was it the other way around? Data on these questions appear in "New Ideas of Space, Time and Motion: 1400–1700," and in "Technics and the Growth of Capitalism."

For any historical study of modern technology, there is no more crucial theme than the relation between technology and science. Most historians and many scientists are agreed that in important respects, the relation is today reciprocal. Advances in "pure" science are rapidly reflected in new technological revolutions. The phrase "science-based corporation" is a popular acknowledgment of this fact.

The mounting debt of science to technology is not always as fully realized. Without the telescope, a technological invention, the science of modern astronomy would have been impossible. Without the microscope, the modern sciences of zoology, biology, and bacteriology would not have developed. But the cases are endless and to be found in nearly every department of modern science and modern technology. One of the latest and most striking debts of science to technology lies in the fields of mathematics and physics. Progress in both is now dependent in part on the high-speed automatic computer. The computer in turn owes its development to information theory, and the researches of the mathematician.

The systematic development of new technical inventions out of the expanding stores of scientific knowledge only became conspicuous in the nineteenth century, although from the time of the Renaissance there was a growing interdependence. The abstractions of science began from 1500 on to furnish ideas to inventors and craftsmen, and the latter paid back their debts with instruments and techniques useful to the scientist.

Charles Singer writes: [6]

> In our own time, technology has become almost synonymous with the application of scientific knowledge to practical ends. To us it seems that science is the source, the parent of technology. Up to about 1500, and perhaps much later, it would be more accurate to say that technology was the parent of science. But from the rather indeterminate period usually called the Renaissance, natural phenomena came to be more and more systematically observed. . . . The rise of the use of experiment and the recession of empiricism from technology will become increasingly evident. . . .

Alfred North Whitehead comments on the strategic change in the relationships between science and technology as follows: [7]

> The greatest invention of the nineteenth century was the invention of the method of invention. A new method entered into life. In order to understand our epoch, we can neglect all the details of change, such as railways, telegraphs, radios, spinning machines, synthetic dyes. We must concentrate on the method in itself; that is the real novelty, which has broken up the foundations of the old civilization. . . . The whole change has arisen from the new scientific information. Science, conceived not so

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[6] Singer et al., *A History of Technology,* Oxford University Press, New York, 1956, p. 274.

[7] A. N. Whitehead, *Science and the Modern World,* The Macmillan Company, New York, 1925, pp. 137–292.

> much in its principles as in its results, is an obvious storehouse of ideas for utilization. But, if we are to understand what happened during the century, the analogy of a mine is better than that of a storehouse. Also, it is a great mistake to think that the bare scientific idea is the required invention, so that it has only to be picked up and used. An intense period of imaginative design lies between. One element in the new method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product. It is a process of disciplined attack upon one difficulty after another.
>
> The possibilities of modern technology were first in practice realized in England, by the energy of a prosperous middle class. Accordingly, the industrial revolution started there. But the Germans explicitly realized the methods by which the deeper veins in the mine of science could be reached. They abolished haphazard methods of scholarship. In their technological schools and universities progress did not have to wait for the occasional genius, or the occasional lucky thought. Their feats of scholarship during the nineteenth century were the admiration of the world. This discipline of knowledge applies beyond technology to pure science, and beyond science to general scholarship. It represents the change from amateurs to professionals.
>
> There have always been people who devoted their lives to definite regions of thought. In particular, lawyers and the clergy of the Christian churches form obvious examples of such specialism. But the full self-conscious realisation of the power of professionalism in knowledge in all its departments, and of the way to produce the professionals, and of the importance of knowledge to the advance of technology, and of the methods by which abstract knowledge can be connected with technology, and of the boundless possibilities of technological advance—the realization of all these things was first completely attained in the nineteenth century; and among the various countries, chiefly in Germany.
>
> In the past human life was lived in a bullock cart; in the future it will be lived in an aeroplane; and the change of speed amounts to a difference in quality.

The last word on this crucial relationship for the past or the future has not been spoken by either scientist or technologist—or by the historian. But some idea of its genesis and vast significance for Industrial Man and his problems may be found in the selections in this section. The next before the last, entitled "The Last Crowded Quarter Century," is especially suggestive. It is a condensed review of the general history of the years 1933 to 1960. Not a scientist or an engineer, but an historian, the author, Allan Nevins nonetheless makes his protagonists modern science and modern technology.

The final selection, written by Robert Oppenheimer, former director of the Manhattan Project, discusses the profound novelties introduced into man's consciousness and culture by these crowded years.

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1. ON EVALUATING TECHNOLOGY IN HISTORY

From Charles Singer et al. (eds.), *A History of Technology,* vol. 2, *The Mediterranean Civilizations and the Middle Ages,* Oxford University Press, New York, 1956, pp. 774–776.

In our time technology has become almost synonymous with the application of scientific knowledge to practical ends. To us it seems that science is the source, the parent, of technology. Up to . . . about 1500, and perhaps much later, it would be more accurate to say that technology was the parent of science. But from the rather indeterminate period usually called the Renaissance, natural phenomena came to be more and more systematically observed. Moreover, knowledge of nature was ever-increasingly elicited by experiment, which is another word for controlled observation—a far more rapid and reliable way of extending knowledge. The rise of the use of experiment and the recession of empiricism from technology will become increasingly evident as these volumes proceed. In parting from this one, it may be well to glance back at the main technological achievements, almost wholly empirical, of the two millennia [500 B.C.–1500 A.D.] under consideration. Many different selections are possible, for each of which much is to be said, and perhaps no two persons would choose precisely the same set of examples.

Some would give first place to the process by which the forces of nature have been made to do the work previously performed by the muscles of men and animals. Thus regarded, primacy would be given to the mill, first the horizontal water-mill, then the vertical mill, then the windmill. It is to be remembered, however, that the development of such machines owes much to a growing mastery of the principles of rotary motion, introduced long before and especially to their application in the construction of gearing. The fabrication and smooth working of mills was facilitated by the introduction of several tools—the screw, the plane, the lathe, the brace, the pulley, and the haulage-tongs—the arrival of all of which comes within our period. The exploitation of new sources of power with the aid of such simple tools may be held to represent the first step in the passage from antiquity to modernity.

Or it might be said that man's prime need is for food and that therefore improvement of crops and stocks must take first place. On this view the change from the dry-farming of the Mediterranean area and the irrigation-methods of the Near East to the drainage-farming and deep ploughing of the heavy soils of the west and north made possible the development of the higher forms of technology in the north-west. A very important place would then be accorded to the improvement of farming-instruments and especially the development of the plough, which opened up northern and western Europe to the possibilities of civilization.

Yet again, since techniques can have no permanent frontiers, everything that increased means of communication, and especially of transport, must have hastened the spread of local devices into wider cultural areas. This line of thought would stress many of the ideas and inventions that have spread from east Asia to west Europe, such as the wheelbarrow, deep drilling, cast iron, lock gates, gimbals, paper, printing, and so on. It would emphasize the importance of the mechanisms of the intercommunication of peoples, such as made roads, passenger-vehicles, the introduction of horses and camels, draught with the horse-collar, advances in the wheelright's craft, and perhaps above all improvements in shipbuilding and navigation.

There is surely a case for judging a civilization by its use of such social surplus as is at the disposal of the favoured few for the lofty purposes of art and literature. This, in a history of technology, would lead to stress on the techniques of the fine arts, such as those of the golden age of Greece with its architecture and sculpture, and of fifteenth-century Italy with its pictorial art and its beginnings of modern science. It would emphasize too the amenities of life introduced by glazing and by blown glass, by paper, parchment, printing, and the luxury of figured weaves. Such a judgement would give less attention to the mechanical advances of the Middle Ages and make the change to modernity rather later than is implied in these volumes.

Others, thinking backward from our time, would see in the period we have here considered the beginnings of types of manufacture characteristic of modern industry. They would attach great importance to metallurgy, specially to the introduction of case-hardened steel and to the newer alloys of copper, notably brass. They would also lay emphasis on the preparation on an industrial scale of substances that include many of those nowadays of prime industrial importance, such as alkalis, pigments and dyes, nitre, alum, soap, and alcohol.

Yet others would claim the prevalence of the scientific mood as the test of modern civilization, since its diffusion has determined the course of our lives today. They would therefore give much attention to instruments of precision in antiquity, to the variety of ingenious and skilfully made measurers of time, and notably to the astrolable. For them the rise of modern science, and, following it, of scientific technology, would be a continuation, *longo intervallo*, of the science of the ancients. On this view, modernity would perhaps begin in the seventeenth century. . . .

All these, and many other, ways of contemplating the technology of the past have had their advocates. On each of these ways many books have been written. But the work now before the reader has been put together in a spirit that takes none of these views. It seeks to present what seem to the authors and editors the salient facts arranged in the best sequence that they have been able to devise, and with that very high degree of condensation of a vast mass of material that is demanded even by these portly volumes. When their task is complete there may emerge a clearer interrelationship of the techniques to each other and to the cultures in which they have arisen. Until that broad view can be taken we must be content to know that techniques, like those who practise them, are all parts one of another, and that we live in a world the unity of which can emerge only very slowly. This may be a hard saying, but it is the way and method of science.

2. HISTORICAL ORIGINS OF THE MACHINE AGE

i. What Is a Machine: Tools, Machines and Utilities Defined

From Lewis Mumford, *Technics and Civilization*, Harcourt, Brace & World, Inc., New York, 1934, pp. 9–12.

During the last century the automatic or semi-automatic machine has come to occupy a large place in our daily routine; and we have tended to attribute to the physical instrument itself the whole complex of habits and methods that created it and accompanied it. Almost every discussion of technology from Marx onward has tended to overemphasize the part played by the more mobile and active parts of our industrial equipment, and has slighted other equally critical elements in our technical heritage. . . .

The essential distinction between a machine and a tool lies in the degree of independence in the operation from the skill and motive power of the operator; the tool lends itself to manipulation, the machine to automatic action. The degree of complexity is unimportant: for, using the tool, the human hand and eye perform complicated actions which are the equivalent, in function, of a well developed machine; while, on the other hand, there are highly effective machines, like the drop hammer, which do very simple tasks, with the aid of a relatively simple mechanism. The difference between tools and machines lies primarily in the degree of automatism they have reached: the skilled tool-user becomes more accurate and more automatic; in short, more mechanical, as his originally voluntary motions settle down into reflexes, and on the other hand, even in the most completely automatic machine, there must intervene somewhere, at the beginning and the end of the process, first in the original design, and finally in the ability to overcome defects and to make repairs, the conscious participation of a human agent.

Moreover, between the tool and the machine there stands another class of objects, the machine-tool: here, in the lathe or the drill, one has the accuracy of the finest machine coupled with the skilled attendance of the workman. When one adds to this mechanical complex an external source of power, the line of division becomes even more difficult to establish. In general, the machine emphasizes specialization of function, whereas the tool indicates flexibility: a planing machine performs only one operation, whereas a knife can be used to smooth wood, to carve it, to split it, or to pry open a lock, or to drive in a screw. The automatic machine, then, is a very specialized kind of adaptation; it involves the notion of an external source of power, a more or less complicated interrelation of parts, and a limited kind of activity. From the beginning the machine was a sort of minor organism, designed to perform a single set of functions.

Along with these dynamic elements in technology there is another set, more static in character, but equally important in function. While the growth of machines is the most patent technical fact of the last thousand years, the machine, in the form of the fire-drill or the potter's wheel, has been in existence since at least neolithic times. During the earlier period, some of the most effective adaptations of the environment came, not from the invention of machines, but from the equally admirable invention of utensils, apparatus, and utilities. The basket and the pot stand for the first, the dye vat and the brick kiln stand for the second, and reservoirs and aqueducts and roads and buildings belong to the third class. The modern period has finally given us the power utility, like the railroad track or the electric transmission line, which functions only through the operation of power machinery. While tools and machines transform the environment by changing the shape and location of objects, utensils and apparatus have been used to effect equally necessary chemical transformations. Tanning, brewing, distilling, dyeing have been as important in man's technical development as smithing or weaving. But most of these processes remained in their traditional state till the middle of the nineteenth century, and it is only since then that they have been influenced in any large degree by the same set of scientific forces and human interests that were developing the modern power-machine.

In the series of objects from utensils to utilities there is the same relation between the workman and the process that one notes in the series between tools and automatic machines: differences in the degree of specialization, the degree of impersonality. But since people's attention is directed most easily to the noisier and more active parts of the environment, the role of the utility and the apparatus has been neglected in most discussions of the machine, or, what is almost as bad, these technical instruments have all been clumsily grouped as machines. The point to remember is that both have played an enormous part in the development of the modern environment; and at no stage in history can the two means of adaptation be split apart. Every technological complex includes both: not least our modern one.

When I use the word machines hereafter I shall refer to specific objects like the printing press or the power loom. When I use the term "the machine" I shall employ it as a shorthand reference to the entire technological complex. This will embrace the knowledge and skills and arts derived from industry or implicated in the new technics, and will include various forms of tool, instrument, apparatus, and utility as well as machine proper.

ii. Ideological Preparation: The Wish before the Fact

From Lewis Mumford, *op. cit.*, pp. 3–7.

During the last thousand years the material basis and the cultural forms of Western Civilization have been profoundly modified by the development of the machine. How did this come about? Where did it take place? What were the chief motives that encouraged this radical transformation of the environment and the routine of life: what were the ends in view; what were the means and methods: what unexpected values have arisen in the process? These are some of the questions that the present study seeks to answer.

While people often call our period the "Machine Age," very few have any perspective on modern technics or any clear notion as to its origins. Popular historians usually date the great transformation in modern industry from Watt's supposed invention of the steam engine; and in the conventional economics textbook the application of automatic machinery to spinning and weaving is often treated as an equally critical turning point. But the fact is that in Western Europe the machine had been developing steadily for at least seven centuries before the dramatic changes that accompanied the "industrial revolution" took place. Men had become mechanical before they perfected complicated machines to express their new bent and interest; and the will-to-order had appeared once more in the monastery and the army and the counting-house before it finally manifested itself in the factory. Behind all the great material inventions of the last century and a half was not merely a long internal development of technics; there were also a change of mind. Before the new industrial processes could take hold on a great scale, a reorientation of wishes, habits, ideas, goals was necessary.

To understand the dominating role played by technics in modern civilization, one must explore in detail the preliminary period of ideological and social preparation. Not merely must one explain the existence of the new mechanical instruments: one must explain the culture that was ready to use them and profit by them so extensively. For note this: mechanization and regimentation are not new phenomena in history: what is new is the fact that these functions have been projected and embodied in organized forms which dominate every aspect of our existence. Other civilizations reached a high degree of technical proficiency without, apparently, being profoundly influenced by the methods and aims of technics. All the critical instruments of modern technology—the clock, the printing press, the water-mill, the magnetic compass, the loom, the lathe, gunpowder, paper, to say nothing of mathematics and chemistry and mechanics—existed in other cultures. The Chinese, the Arabs, the Greeks, long before the Northern European had taken most of the first steps toward the machine. And although the great engineering works of the Cretans, the Egyptians, and the Romans were carried out mainly on an empirical basis, these peoples plainly had an abundance of technical skill at their command. They had machines; but they did not develop "the machine." It remained for the peoples of Western Europe to carry the physical sciences and the exact arts to a point no other culture had reached, and to adapt the whole mode of life to the pace and the capacities of the machine. How did this happen? How in fact could the machine take possession of European society until that society had, by an inner accommodation, surrendered to the machine?

Plainly, what is usually called *the* industrial revolution, the series of industrial changes that began in the eighteenth century, was a transformaton that took place in the course of a much longer march.

Technics and civilization as a whole are the result of human choices and aptitudes and strivings, deliberate as well as unconscious, often irrational when apparently they are most objective and scientific: but even when they are uncontrollable they are not external. Choice manifests itself in society in small increments and moment-to-moment decisions as well as loud dramatic struggles; and he who does not see his choice in the development of the machine merely betrays his incapacity to observe cumulative effects until they are bunched together so closely that they seem completely external and impersonal. No matter how completely technics relies upon the objective procedures of the sciences, it does not form an independent system, like the universe: it exists as an element in human culture and it promises well or ill as the social groups that exploit it promise well or ill. The machine itself makes no demands and holds out no promises: it is the human spirit that makes demands and keeps promises. In order to reconquer the machine and subdue it to human purposes, one must first understand it and assimilate it. So far, we have embraced the machine without fully understanding it, or, like the weaker romantics, we have rejected the machine without first seeing how much of it we could intelligently assimilate.

iii. Time and the Machine: Authority of the Clock

From Lewis Mumford, *op. cit.*, pp. 12–18.

Where did the machine first take form in modern civilization? There was plainly more than one point of origin. Our mechanical civilization represents the convergence of numerous habits, ideas, and modes of living, as well as technical instruments; and some of these were, in the beginning, directly opposed to the civilization they helped to create. But the first manifestation of the new order took place in the general picture of the world: during the first seven centuries of the machine's existence the categories of time and space underwent an extraordinary change, and no aspect of life was left untouched by this transformation. The application of quantitative methods of thought to the study of nature had its first manifestation in the regular measurement of time; and the new mechanical conception of time arose in part out of the routine of the monastery. Alfred Whitehead has emphasized the importance of the scholastic belief in a universe ordered by God as one of the foundations of modern physics; but behind that belief was the presence of order in the institutions of the Church itself.

The technics of the ancient world were still carried on from Constantinople and Baghdad to Sicily and Cordova: hence the early lead taken by Salerno in the scientific and medical advances of the Middle Ages. It was, however, in the monasteries of the West that the desire for order and power, other than that expressed in the military domination of weaker men, first manifested itself after the long uncertainty and bloody confusion that attended the breakdown of the Roman Empire. Within the walls of the monastery was sanctuary: under the rule of the order surprise and doubt and caprice and irregularity were put at bay. Opposed to the erratic fluctuations and pulsations of the wordly life was the iron discipline of the rule. Benedict added a seventh period to the devotions of the day, and in the seventh century, by a bull of Pope Sabinianus, it was decreed that the bells of the monastery be rung seven times in the twenty-four hours. These punctuation marks in the day were known as the canonical hours, and some means of keeping count of them and ensuring their regular repetition became necessary.

According to a now discredited legend, the first modern mechanical clock, worked by falling weights, was invented by the monk named Gilbert who afterwards became Pope Sylvester II near the close of the tenth century. This clock was probably only a water clock, one of those bequests of the ancient world either left over directly from the days of the Romans like the water-wheel itself, or coming back again into the West through the Arabs. But the legend, as so often happens, is accurate in its implications if not in its facts. The monastery was the seat of a regular life, and an instrument for striking the hours at intervals or for reminding the bell-ringer that it was time to strike the bells, was an almost inevitable product of this life. If the mechanical clock did not appear until the cities of the thirteenth century demanded an orderly routine, the habit of order itself and the earnest regulation of time-sequences had become almost second nature in the monastery. Coulton agrees with Sombart in looking upon the Benedictines, the great working order, as perhaps the original founders of modern capitalism: their rule certainly took the curse off work and their vigorous engineering enterprises may even have robbed warfare of some of its glamor. So one is not straining the facts when one suggests that the monasteries—at one time there were 40,000 under the Benedictine rule—helped to give human enterprise the regular collective beat and rhythm of the machine; for the clock is not merely a means of keeping track of the hours, but of synchronizing the actions of men.

Was it by reason of the collective Christian desire to provide for the welfare of souls in eternity by regular prayers and devotions that time-keeping and the habits of temporal order took hold of men's minds: habits that capitalist civilization presently turned to good account? One must perhaps accept the irony of this paradox. At all events, by the thirteenth century there are definite records of mechanical clocks, and by 1370 a well-designed "modern" clock had been built by Heinrich von Wyck at Paris. Meanwhile, bell towers had come into existence, and the new clocks, if they did not have, till the fourteenth century, a dial and a hand that translated the movement of time into a movement through space, at all events struck the hours. The clouds that could paralyze the sundial, the freezing that could stop the water clock on a winter night, were no longer obstacles to time-keeping: summer or winter, day or night, one was aware of the measured clank of the clock. The instrument presently spread outside the monastery; and the regular striking of the bells brought a new regularity into the life of the workman and the merchant. The bells of the clock tower almost defined urban existence. Time-keeping passed into time-serving and time-accounting and time-rationing. As this took place, Eternity ceased gradually to serve as the measure and focus of human actions.

The clock, not the steam-engine, is the key-machine of the modern industrial age. For every phase of its development the clock is both the outstanding fact and the typical symbol of the machine: even today no other machine is so ubiquitous. Here, at the very beginning of modern technics, appeared prophetically the accurate automatic machine which, only after centuries of further effort, was also to prove the final consummation of this technics in every department of industrial activity. There had been power-machines, such as the water-mill, before the clock; and there had also been various kinds of automata, to awaken the wonder of the populace in the temple, or to please the idle fancy of some Moslem caliph: machines one finds illustrated in Hero and Al-Jazari. But here was a new kind of power-machine, in which the source of power and the transmission were of such a nature as to ensure the even flow of energy throughout the works and to make possible regular production and a standardized product. In its relationship to determinable quantities of energy, to standardization, to automatic action, and finally to its own special product, accurate timing, the clock has been the foremost machine in modern technics: and at each period it has remained in the lead: it marks a perfection toward which other machines aspire. The clock, moreover, served as a model for many other kinds of mechanical works, and the analysis of motion that accompanied the perfection of the clock, with the various types of gearing and transmission that were elaborated, contributed to the success of quite different kinds of machine. Smiths could have hammered thousands of suits of armor or thousands of iron cannon, wheelwrights could have shaped thousands of great water-wheels or crude gears, without inventing any of the special types of movement developed in clockwork, and without any of the accuracy of measurement and fineness of articulation that finally produced the accurate eighteenth century chronometer.

The clock, moreover, is a piece of power-machinery whose "product" is seconds and minutes: by its essential nature it dissociated time from human events and helped create the belief in an independent world of mathematically measurable sequences: the special world of science. There is relatively little foundation for this belief in common human experience: throughout the year the days are of uneven duration, and not merely does the relation between day and night steadily change, but a slight journey from East to West alters astronomical time by a certain number of minutes. In terms of the human organism itself, mechanical time is even more foreign: while human life has regularities of its own, the beat of the pulse, the breathing of the lungs, these change from hour to hour with mood and action, and in the longer span of days, time is measured not by the calendar but by the events that occupy it. The shepherd measures from the time the ewes lambed; the farmer measures back to the day of sowing or forward to the harvest; if growth has its own duration and regularities, behind it are not simply matter and motion but the facts of development: in short, history. And while mechanical time is strung out in a succession of mathematically isolated instants, organic time—what Bergson calls duration—is cumulative in its effects. Though mechanical time can, in a sense, be speeded up or run backward, like the hands of a clock or the images of a moving picture, organic time moves in only one direction—through the cycle of birth, growth, development, decay, and death—and the past that is already dead remains present in the future that has still to be born.

Around 1345, according to Thorndike, the division of hours into sixty minutes and of minutes into sixty seconds became common: it was this abstract framework of divided time that became more and more the point of reference for both action and thought, and in the effort to arrive at accuracy in this department, the astronomical exploration of the sky focussed attention further upon the regular, implacable movements of the heavenly bodies through space. Early in the sixteenth century a young Nuremberg mechanic, Peter Henlein, is supposed to have created "many-wheeled watches out of small bits of iron" and by the end of the century the small domestic clock had been introduced in England and Holland. As with the motor car and the airplane, the richer classes first took over the new mechanism and popularized it: partly because they alone could afford it, partly because the new bourgeoisie were the first to discover that, as Franklin later put it, "time is money." To become "as regular as clockwork" was the bourgeois ideal, and to own a watch was for long a definite symbol of success. The increasing tempo of civilization led to a demand for greater power: and in turn power quickened the tempo.

Now, the orderly punctual life that first took shape in the monasteries is not native to mankind, although by now Western peoples are so thoroughly regimented by the clock that it is "second nature" and they look upon its observance as a fact of nature. Many Eastern civilizations have flourished on a loose basis in time: the Hindus have in fact been so indifferent to time that they lack even an authentic chronology of the years. Only yesterday, in the midst of the industrializations of Soviet Russia, did a society come into existence to further the carrying of watches there and to propagandize the benefits of punctuality. The popularization of time-keeping, which followed the production of the cheap standardized watch, first in Geneva, then in America around the middle of the last century, was essential to a well-articulated system of transportation and production.

To keep time was once a peculiar attribute of music: it gave industrial value to the workshop song or the tattoo or the chantey of the sailors tugging at a rope. But the effect of the mechanical clock is more pervasive and strict: it presides over the day from the hour of rising to the hour of rest. When one thinks of the day as an abstract span of time, one does not go to bed with the chickens on a winter's night: one invents wicks, chimneys, lamps, gaslights, electric lamps, so as to use all the hours belonging to the day. When one thinks of time, not as a sequence of experiences, but as a collection of hours, minutes, and seconds, the habits of adding time and saving time come into existence. Time took on the character of an enclosed space: it could be divided, it could be filled up, it could even be expanded by the invention of labor-saving instruments.

Abstract time became the new medium of existence. Organic functions themselves were regulated by it: one ate, not upon feeling hungry, but when prompted by the clock; one slept, not when one was tired, but when the clock sanctioned it. A generalized time-consciousness accompanied the wider use of clocks: dissociating time from organic sequences, it became easier for the men of the Renascence to indulge the fantasy of reviving the classic past or of reliving the splendors of antique Roman civilization: the cult of history, appearing first in daily ritual, finally abstracted itself as a special discipline. In the seventeenth century journalism and periodic literature made their appearance: even in dress, following the lead of Venice as fashion-center, people altered styles every year rather than every generation.

The gain in mechanical efficiency through co-ordination and through the closer articulation of the day's events cannot be overestimated: while this increase cannot be measured in mere horsepower, one has only to imagine its absence today to foresee the speedy disruption and eventual collapse of our entire society. The modern industrial regime could do without coal and iron and steam easier than it could do without the clock.

iv. Monasteries and Mechanization

From Bertrand Gille, "Machines," in Charles Singer et al. (eds.), *A History of Technology*, vol. 2, *The Mediterranean Civilizations and the Middle Ages*, Oxford University Press, New York, 1956, pp. 650–651.

There was . . . one important type of concentration of manufacture that favoured mechanization. This is exemplified by the monasteries, particularly those of the Cistercian order, which formed the sole economic autarkies of the Middle Ages. They played a major part in the development of machinery and in particular of the various applications of the water-mill.

In principle, and generally in practice, each monastery had itself to meet all its own needs. To avoid unnecessary labour, which reduced the time available for meditation and prayer, all manufactures in monastic hands were mechanized as far as possible. For this reason the Cistercian regulations recommend that monasteries should be built near rivers that could supply power. A description of Clairvaux Abbey in France gives some idea of this mechanization:

> The river enters the abbey as much as the wall acting as a check allows. It gushes first into the corn-mill where it is very actively employed in grinding the grain under the weight of the wheels and in shaking the fine sieve which separates flour from bran. Thence it flows into the next building, and fills the boiler in which it is heated to prepare beer for the monks' drinking, should the vine's fruitfulness not reward the vintner's labour. But the river has not yet finished its work, for it is now drawn into the fulling-machines following the corn-mill. In the mill it has prepared the brothers' food and its duty is now to serve in making their clothing. This the river does not withhold, nor does it refuse any task asked of it. Thus it raises and lowers alternately the heavy hammers and mallets, or to be more exact, the wooden feet of the fulling-machines. When by swirling at great speed it has made all these wheels revolve swiftly it issues foaming and looking as if it had ground itself. Now the river enters the tannery where it devotes much care and labour to preparing the necessary materials for the monks' footwear; then it divides into many small branches and, in its busy course, passes through the various departments, seeking everywhere for those who require its services for any purpose whatsoever, whether for cooking, rotating, crushing, watering, washing, or grinding, always offering its help and never refusing. At last, to earn full thanks and to leave nothing undone, it carries away the refuse and leaves all clean.

Most early abbeys had an extensive water-system of this type. In some of them the various hydraulic workshops were concentrated in a single factory, as, for example, at the French abbey of Royaumont, near Paris. There the "works" was built over the river itself, which passed along the axis of the building through a high and narrow tunnel 32 m long and 2.35 m wide. The workshops supplying the material needs of the abbey, such as the grain-, tanning-, fulling-, and iron-mills, were situated on each side of this tunnel. At the abbey of Vaux de Cernay, also near Paris, there was a similar works. The abbey of Fontenay in Burgundy still has its factory, a huge structure with four rooms built at the end of the twelfth century and measuring 53 m long by 13.50 m wide. The forge was in the second room. The river passed alongside the building and the grain-mill was at the end and built over the river.

Many other Cistercian abbeys had similar buildings where all the equipment used for their work was concentrated. In the twelfth-century Fountains Abbey, Yorkshire, an underground river passes through a series of tunnels feeding a brewery, a corn-mill, and various workshops. There were also private factories in the Limousin district in France; the Materre mills included those for corn, hemp, and tanning. In the same district there was a single mill which dealt with flour-grinding, cloth-fulling, and tanning.

v. Leonardo da Vinci: "Compleat Technician"

From Bertrand Gille, *op. cit.*, pp. 651, 652.

The first medieval technical revolution occurred in the twelfth and thirteenth centuries. The fourteenth century was a period of adaptation, when the disastrous Hundred Years War (1338–1453) between England and France, and the Black Death (1348–50), contributed not a little to a slackening of progress. This was to reappear with added vigour in the second half of the fifteenth century.

The new phase of technical advancement occurred in a region distant from the protracted war. Northern Italy, southern Germany, and the Rhine valley enjoyed a very rapid cultural evolution—the beginnings of a renaissance in art, literature, science, and technology. Now appeared the first of the long line of engineers who were later to form or to train the various groups of technicians—men who were at the same time architects, mechanical engineers, and military engineers.

Leonardo da Vinci's description of himself when writing to the Duke of Milan corresponds perfectly to this new definition of the "compleat technician." He says that he has a process for the construction of very light bridges, capable of easy transport. He knows how to drain moats and make scaling-ladders. He knows how to make light cannon easy of transport, capable of ejecting inflammable matter. By narrow and tortuous subterranean tunnels, he can create a passage to inaccessible places, even under rivers. He can make cannon, mortars, and engines of fire different from those now in use, and can replace them by catapults and other projectile weapons at present unknown. He can compete with anyone in architecture, and in the building of canals.

This superbly gifted technician had of course progressed far beyond his predecessors. He had a better knowledge of science than they, and was more given to conscious thought on the development of the means at his disposal. The development of machinery now required comprehensive solutions of problems. Interposed between prime-mover and operative tools there must be mechanisms that do not belong specifically to any one of the five simple machines. There are also such general problems as friction, the transformation of motion, and the reduction and augmentation of power. Moreover, there are problems of stresses and strains in materials, problems of mechanization in a multitude of machines, and, above all, strictly scientific problems that became soluble only when science had adopted the experimental method. On all of these Leonardo touches in his notebooks.

3. NEW IDEAS OF SPACE, TIME AND MOTION

From Lewis Mumford, *op. cit.*, pp. 20–22.

Between the fourteenth and the seventeenth century a revolutionary change in the conception of space took place in Western Europe. Space as a hierarchy of values was replaced by space as a system of magnitudes. One of the indications of this new orientation was the closer study of the relations of objects in space and the discovery of the laws of perspective and the systematic organization of pictures within the new frame fixed by the foreground, the horizon and the vanishing point. Perspective turned the symbolic relation of objects into a visual relation: the visual in turn became a quantitative relation. In the new picture of the world, size meant not human or divine importance, but distance. Bodies did not exist separately as absolute magnitudes: they were co-ordinated with other bodies within the same frame of vision and must be in scale. To achieve this scale, there must be an accurate representation of the object itself, a point for point correspondence between the picture and the image: hence a fresh interest in external nature and in questions of fact. The division of the canvas into squares and the accurate observation of the world through this abstract checkerboard marked the new technique of the painter, from Paolo Uccello onward.

The new interest in perspective brought depth into the picture and distance into the mind. In the older pictures, one's eye jumped from one part to another, picking up symbolic crumbs as taste and fancy dictated: in the new pictures, one's eye followed the lines of linear perspective along streets, buildings, tessellated pavements whose parallel lines the painter purposely introduced in order to make the eye itself travel. Even the objects in the foreground were sometimes grotesquely placed and foreshortened in order to create the same illusion. Movement became a new source of value: movement for its own sake. The measured space of the picture re-enforced the measured time of the clock.

Within this new ideal network of space and time all events now took place; and the most satisfactory event within this system was uniform motion in a straight line, for such motion lent itself to accurate representation within the system of spatial and temporal co-ordinates. One further consequence of this spatial order must be noted: to place a thing and to time it became essential to one's understanding of it. In Renascence space, the existence of objects must be accounted for: their passage through time and space is a clue to their appearance at any particular moment in any particular place. The unknown is therefore no less determinate than the known: given the roundness of the globe, the position of the Indies could be assumed and the time-distance calculated. The very existence of such an order was an incentive to explore it and to fill up the parts that were unknown.

What the painters demonstrated in their application of perspective, the cartographers established in the same century in their new maps. The Hereford Map of 1314 might have been done by a child: it was practically worthless for navigation. That of Uccello's contemporary, Andrea Banco, 1436, was conceived on rational lines, and represented a gain in conception as well as in practical accuracy. By laying down the invisible lines of latitude and longitude, the cartographers paved the way for later explorers, like Columbus: as with the later scientific method, the abstract system gave rational expectations, even if on the basis of inaccurate knowledge. No longer was it necessary for the navigator to hug the shore line: he could launch out into the unknown, set his course toward an arbitrary point, and return approximately to the place of departure. Both Eden and Heaven were outside the new space; and though they lingered on as the ostensible subjects of painting, the real subjects were Time and Space and Nature and Man.

Presently, on the basis laid down by the painter and the cartographer, an interest in space as such, in movement as such, in locomotion as such, arose. In back of this interest were of course more concrete alterations: roads had become more secure, vessels were being built more soundly, above all, new inventions—the magnetic needle, the astrolabe, the rudder —had made it possible to chart and to hold a more accurate course at sea. The gold of the Indies and the fabled fountains of youth and the happy isles of endless sensual delight doubtless beckoned too: but the presence of these tangible goals does not lessen the importance of the new schemata. The catagories of time and space, once practically dissociated, had become united: and the abstractions of measured time and measured space undermined the earlier conceptions of infinity and eternity, since measurement must begin with an arbitrary here and now even if space and time be empty. The itch to *use* space and time had broken out: and once they were co-ordinated with movement, they could be contracted or expanded: the conquest of space and time had begun. (It is interesting, however, to note that the very concept of acceleration, which is part of our daily mechanical experience, was not formulated till the seventeenth century.)

The signs of this conquest are many: they came forth in rapid succession. In military arts the cross-bow and the ballista were revived and extended, and on their heels came more powerful weapons for annihilating distance—the cannon and later the musket. Leonardo conceived an airplane and built one. Fantastic projects for flight were canvassed. In 1420 Fontana described a velocipede: in 1589 Gilles de Bom of Antwerp apparently built a man-propelled wagon: restless preludes to the vast efforts and initiatives of the nineteenth century. As with so many elements in our culture, the original impulse was imparted to this movement by the Arabs: as early as 880 Abû l-Qâsim had attempted flight, and in 1065 Oliver of Malmesbury had killed himself in an attempt to soar from a high place: but from the fifteenth century on the desire to conquer the air became a recurrent preoccupation of inventive minds; and it was close enough to popular thought to make the report of a flight from Portugal to Vienna serve as a news hoax in 1709.

The new attitude toward time and space infected the workshop and the counting house, the army and the city. The tempo became faster: the magnitudes became greater: conceptually, modern culture launched itself into space and gave itself over to movement.

4. TECHNICS AND THE GROWTH OF CAPITALISM

From Lewis Mumford, *op. cit.*, pp. 26–27.

While the feudal families, with their command over the land, often had a monopoly over such natural resources as were found in the earth, and often retained an interest in glass-making, coal-mining, and iron-works right down to modern times, the new mechanical inventions lent themselves to exploitation by the merchant classes. The incentive to mechanization lay in the greater profits that could be extracted through the multiplied power and efficiency of the machine.

Thus, although capitalism and technics must be clearly distinguished at every stage, one conditioned the other and reacted upon it. The merchant accumulated capital by widening the scale of his operations, quickening his turnover, and discovering new territories for exploitation: the inventor carried on a parallel process by exploiting new methods of production and devising new things to be produced. Sometimes trade appeared as a rival to the machine by offering greater opportunities for profit: sometimes it curbed further developments in order to increase the profit of a particular monopoly: both motives are still operative in capitalist society. From the first, there were disparities and conflicts between these two forms of exploitation: but trade was the older partner and exercised a higher authority. It was trade that gathered up new materials from the Indies and from the Americas, new foods, new cereals, tobacco, furs: it was trade that found a new market for the trash that was turned out by eighteenth century mass-production: it was trade—abetted by war—that developed the large-scale enterprises and the administrative capacity and method that made it possible to create the industrial system as a whole and weld together its various parts.

Whether machines would have been invented so rapidly and pushed so zealously without the extra incentive of commercial profit is extremely doubtful: for all the more skilled handicraft occupations were deeply entrenched, and the introduction of printing, for example, was delayed as much as twenty years in Paris by the bitter opposition of the guild of scribes and copyists. But while technics undoubtedly owes an honest debt to capitalism, as it does likewise to war, it was nevertheless unfortunate that the machine was conditioned, at the outset, by these foreign institutions and took on characteristics that had nothing essentially to do with the technical processes or the forms of work. Capitalism utilized the machine, not to further social welfare, but to increase private profit: mechanical instruments were used for the aggrandizement of the ruling classes. It was because of capitalism that the handicraft industries in both Europe and other parts of the world were recklessly destroyed by machine products, even when the latter were inferior to the thing they replaced: for the prestige of improvement and success and power was with the machine, even when it improved nothing, even when technically speaking it was a failure. It was because of the possibilities of profit that the place of the machine was overemphasized and the degree of regimentation pushed beyond what was necessary to harmony or efficiency. It was because of certain traits in private capitalism that the machine—which was a neutral agent—has often seemed, and in fact has sometimes been, a malicious element in society, careless of human life, indifferent to human interests. The machine has suffered for the sins of capitalism; contrariwise, capitalism has often taken credit for the virtues of the machine.

By supporting the machine, capitalism quickened its pace, and gave a special incentive to preoccupation with mechanical improvements: though it often failed to reward the inventor, it succeeded by blandishments and promises in stimulating him to further effort. In many departments the pace was over-accelerated, and the stimulus was over-applied: indeed, the necessity to promote continual changes and improvements, which has been characteristic of capitalism, introduced an element of instability into technics and kept society from assimilating its mechanical improvements and integrating them in an appropriate social pattern. As capitalism itself has developed and expanded, these vices have in fact grown more enormous, and the dangers to society as a whole have likewise grown proportionately. Enough here to notice the close historical association of modern technics and modern capitalism, and to point out that, for all this historical development, there is no necessary connection between them.

5. THE LAST CROWDED QUARTER CENTURY

From Allan Nevins, "Assay of an Epochal Quarter-Century," *The New York Times Magazine,* Mar. 30, 1958, pp. 14 ff.

We have now completed a quarter-century since Franklin D. Roosevelt and Hitler in their very different ways rose to power, doubtless the most crowded quarter-century in the history of mankind. As we peer back at the luminous peaks—political, scientific and social—in the landscape of change, we are tempted to pronounce the period unique. "Assuredly," we say, "the release of nuclear energy alone stamps the era as epochal."

It is true, of course, that quarter-century divisions are completely artificial, for history cannot be divided in this fashion. The past can no more be packaged by quarter-centuries than the force and body of the Mississippi can be partitioned by features of its banks. Much that was accomplished in the period 1933–1958 was rooted in distant years, and atomic fission is the achievement of Lord Rutherford's day as well as our own.

Still, if we are to mark off eras for convenient summation, the quarter-century division has become a necessity. A slower world used to count its great forward steps by centuries. No doubt it had a prehistoric century of Fire-capture; another of the Wheel; still another, going fully as far back as 3500 B.C., of the Arch. We may well speak of the century of the Renaissance, of the Reformation and of the Industrial Revolution. But, as Henry Adams observed, the march of mankind constantly accelerates. Like the galaxies in outer space, receding and reddening, it moves faster and faster. We thought the first quarter-century after 1900 marvelous enough with its wireless, radium, women's rights, Freudianism, break-up of empires, and League of Nations. But the past quarter-century has been more rapid, lustrous and appalling in a much wider range of activities.

Since the "gale" of the Second World War, twenty new nations have come into existence, with an area of nearly 5,000,000 square miles, and a population of some 700,000,000 people. In the global scales, Asia and Africa have gained vastly in weight, while Europe has lost half its prestige and power. In the twenty new nations, the pressures for an economic security which will bulwark their political independence have become tremendous. From the dead League has arisen a brighter phoenix; partly to contain and guide the political ambitions of countries old and new, the United Nations has maintained its vigor and offered growing hope of a system of collective security. During the first decade after the war, not far from three-quarters of a billion people were cast into the noxious gulf of communism. But to counteract this calamity, the free lands of the globe have united their resources and policies in by far the greatest alliance ever made.

Meanwhile, Western industry has moved from a widespread adoption of the complex processes of mass production to an initial acceptance of the yet more complicated requirements of automatism. Both are so new that few people really understand them. The ordinary man equates mass production with mere quantity production, and automatism with a few automatic machines, when both actually require a union of many elements and an almost complete reorganization of large-scale production. In short, one basically revolutionary change is now being followed by another, to the marked enrichment of mankind. In medicine, fresh discoveries in methods, and the addition of new vaccines and antitoxins, of insulin, the sulfa drugs, and penicillin and other antibiotics to the arsenal of every hospital, have reduced suffering and prolonged life.

In the air, advance has followed advance, until plane travel now matches railroad and bus patronage; London and New York—and, alas, the Soviet and American airfields and missile bases—are only a few hours apart. The first man-made satellites have lent a new immediacy to dreams of excursions to the moon. The idea that the economic health of America and that of Western Europe are indissolubly united has gained an acceptance that would have seemed incredible in the days of the Smoot-Hawley tariff. The highest mountain of the Himalayas, and the deepest recesses of the Antarctic and Arctic have been conquered. In every advanced country electronics, artificial fibers, synthetic rubber and ever-new plastics have become a familiar part of daily living. Earth movers have transformed ancient landscapes.

Our own country has seen automobiles, trucks and tractors manufactured in numbers that have merged city and country into one, enormously lightened farming and lumbering, altered the entire meaning of distance and threatened to convert the land into one huge roadway. As part of the motorcar revolution, suburbia has grown at breakneck speed. The subdivider has taken over decaying farms, elongated the railway platforms, and built filling stations, parking lots and neon-sign restaurants; builders have created quantity-produced Levittowns where young couples rear astonishing numbers of babies; architects have blossomed forth more luxuriantly than ever with Tudor houses, Mexican villas and ranch shacks. For these new suburbs with their two-car garages, air-conditioning and neighborhood clubs, novel amenities have had to be provided, and supermarkets have spread everywhere until they coagulate with other facilities in super-shopping centers.

From Alexandria, Va., to Nahant, Mass., towns and cities have merged into a continuous belt of settlement, a Megalopolis with a special life of its own. To serve it, superhighways and thruways have cut across the land; to control it, zoning and planning have all too slowly crept in. In the rotting hearts of the older centers slum clearance—a dubious novelty little over a quarter-century ago—has become imperative. In this Atlantic belt city all the problems of urbanism, from sanitation to juvenile delinquency, have become intensified.

Looming high above all other changes, the parent of both high elation and deep foreboding, stands the development of atomic energy. From every point of view, some observers will say, the greatest date in the quarter-century was Dec. 2, 1942, when Fermi's workers in Arthur H. Compton's laboratory at the University of Chicago obtained the first nuclear chain reaction. For better, or for worse? For giving a new omnipotence, as Hiroshima suggested, to "Moloch, horrid king, besmeared with blood of human sacrifice, and parents' tears"? Or, as the American and British groups now laboring to tame nuclear power for industrial uses promise us, to release mankind from its age-old fetters of toil and want, and make possible a concentration of human effort on higher objectives? We cannot yet say. The next quarter-century will show.

Taking the broadest view of these changes, what is their meaning?

To many, it would seem plain that this quarter-century has been above all a time of material progress; that it has been the period in which science, as a materialistic force, finally asserted its dominant place in human affairs; it alone is to govern us.

Science, long a very minor goddess, did not begin to grow in importance until the time of Roger Bacon and later; but by the seventeenth century she was attaining a full and noble stature. And in the days of the Industrial Revolution she acquired a smoke-blackened, oil-stained slave called Technology. At times during the nineteenth century it seemed that the slave was overshadowing his mistress. He would glance about impudently, assume airs of authority, and undertake vast enterprises all his own. As he learned to make huge amounts of money in them, he commanded a powerful following. But in the last twenty-five years Science has suddenly towered higher than ever, and has snapped her whip across the back of Technology—indeed, has snapped it over the entire world.

For Science, which used to deal with somewhat external matters, has now gone to the fundamental laws of the universe. She has found the secret of the eternal incandescence of the stars, and brought a new Promethean fire from the skies. Nobody can deny her potency. The great scientific explorers of our time have changed, or are changing, the whole pattern of men's lives. They have revolutionized military defense, making it an unprecedented problem and an endless burden. They have radically altered the nature of men's thinking about power politics, money, taxation, natural resources and other vitally important subjects. Even as these lines are being read the harnessers of nuclear power for peaceful use may be bringing to birth the greatest economic revolution in human annals, to be followed by an unpredictable social revolution.

In many detailed ways the new Science works her marvels. The engineer used to analyze a metal, for example, by physical tests—taking samples, hammering them, and making chemical evaluations. Now he employs advanced X-ray and spectroscopic devices to ascertain how the atoms of the metal are arranged and how they behave, and by this ultra-microscopic method he finds out far more than ever before.

But is it safe to accept this view that the quarter-century proves, above all, the ascendancy of science and materialism? Nearly all the changes enumerated—those of the new air age, the automotive age, the plastic and electronic age, the rise of suburbia, the birth of Megalopolis, the hydrogen bomb—are materialistic in nature. If science has an ideal side, it has not been very apparent. But when we peer more closely into recent years, we see that we have neglected a startling array of moral and intellectual changes.

American history has witnessed some exceedingly rapid and dramatic revolutions in sentiment. But we are probably warranted in saying that never has the nation experienced so many profound alterations in thought and outlook as during the past quarter-century.

Probably the most signal change relates to our international outlook. The isolationism that was so powerful in 1933—that controlled the Republican party and intimidated F.D.R. and the liberal Democrats—has vanished into thin air. As invoked by Borah and Wheeler, it prevented the nation from entering even the harmless World Court. But today our leadership in the United Nations is almost universally regarded as essential. The new internationalism is no less strong in economic than in political affairs. Both parties stand firmly for the principles of low tariffs and freer international trade. Both support the principle of economic aid, not as a temporary expedient but as a permanent policy.

Our attitude toward some cardinal issues of social justice has undergone no less drastic a change. The rights of the worker furnish a notable instance. In the late Nineteen Twenties organized labor was puny and discouraged. Yet by the mid-Thirties the Wagner Act registered a revolution in sentiment that was already far advanced.

Equally rapid has been the change in our attitude toward social insurance. In 1931 . . . the "dole" was a term of derision and reproach, suggesting European degeneracy. But the depression cured us of that antiquated attitude. When twelve millions were out of jobs, millions hungry and scores of millions convinced that our economic system had broken down, we ceased to shudder at the "dole." Save in the medical field, the United States today has a system of welfare insurance that can stand comparison with any abroad.

As we look into the future, we can make a few predictions with reasonable confidence. We can assert that the pattern of the immediate future will necessarily fit the pattern of the near past; that the movement of societies and nations will continue to gain acceleration; that we shall continue to face the paradox that the more man conquers Nature (and unlocks its genii) the greater the danger that Nature will crush man. We can say that the next quarter-century may well witness a revolution in our control of energy, and hence welfare and leisure, that will dwarf most revolutions of the past.

We can be certain, too, that the necessity for a cultural and moral growth to arm us to meet change will grow urgently, even ferociously. The voices which counsel us to spend all our energies on science are sinister counsel. Most of our energies must go to development of the intelligence and character which can control science. Even in the short-run necessities of the cold war it is culture in the broadest sense that we need.

Caught as we are in a fateful rivalry with another Great Power which would overthrow our whole system, we must keep our nation symmetrically healthy. Our capacity to make revolutionary decisions in social, cultural and moral fields is just as important as our capacity to make epochal scientific discoveries. Indeed, it is more important, for science is but the handmaiden of our society and culture. It would avail us nothing to gain a nuclear ascendancy and lose our own souls. That is one reason why we must guard against a distortion of our education, our creative activities and our entire way of life in the name of scientific leadership. The most powerful and influential nation a quarter-century hence will not be the one that has met the challenge of science most energetically; it will be the one that has met all the hundred challenges which make for a luminous, well-rounded civilization.

6. THE OPEN MIND

From J. R. Oppenheimer, *The Open Mind*, Simon and Schuster, Inc., New York, 1955, pp. 140–141.

In an important sense this world of ours is a new world, in which the unity of knowledge, the nature of human communities, the order of society, the order of ideas, the very notions of society and culture have changed and will not return to what they have been in the past. What is new is new not because it has never been there before, but because it has changed in quality. One thing that is new is the prevalence of newness, the changing scale and scope of change itself, so that the world alters as we walk in it, so that the years of man's life measure not some small growth or rearrangement or moderation of what he learned in childhood, but a great upheaval. What is new is that in one generation our knowledge of the natural world engulfs, upsets, and complements all knowledge of the natural world before. The techniques, among which and by which we live, multiply and ramify, so that the whole world is bound together by communication, blocked here and there by the immense synapses of political tyranny. The global quality of the world is new: our knowledge of and sympathy with remote and diverse peoples, our involvement with them in practical terms, and our commitment to them in terms of brotherhood. What is new in the world is the massive character of the dissolution and corruption of authority, in belief, in ritual, and in temporal order. Yet this is the world that we have come to live in. The very difficulties which it presents derive from growth in understanding, in skill, in power. To assail the changes that have unmoored us from the past is futile, and in a deep sense, I think, it is wicked. We need to recognize the change and learn what resources we have.

PART TWO

PROBLEMS AND PROMISE OF THE MACHINE AGE

A. THE MACHINE AGE: A PROLOGUE

Part Two of this book begins with a broad review of technological trends in the twentieth century, written by the late William Fielding Ogburn, leading American authority on the social impact of technology. This selection is taken from the introductory chapter of a famous government report made to the President of the United States in 1937. It discusses the bearing of major technological advances on social and economic life and on national policy.

Although the essay cites examples only from the first thirty-five years of the twentieth century, it remains the best brief general introduction to an understanding of the problems and promise of the machine age. Following this prologue is a more detailed study of the impact of technological trends on man-machine relationships, on organizations, on money and motivation, and on acceleration of change in the modern world.

1. NATIONAL POLICY AND TECHNOLOGY

From W. F. Ogburn, "National Policy and Technology," *Technological Trends and National Policy*, Report of the Subcommittee on Technology to the National Resources Committee, Government Printing Office, 1937.

The sigificance of technology for economic and social life may be shown by considering certain developments of the twentieth century. Only 35 years have elapsed since the beginning of the century, during which time the Nation has experienced a phase of unparalleled development. Most of the Members of the present Congress had at that time finished school and college, and were already launched on the career that was to place them among the policy-makers of the Nation. It would have been enlightening for them to have looked ahead then at the probable course of technology. A scanning of the technological horizon at that time would have revealed the beginnings of several of our largest industries, based upon inventions then relatively new.

For instance, there were not many telephones in use in 1900, around a million in number. Yet the telephone industry was destined to grow into the third largest public utility in the United States, with an investment of nearly $5,000,000,000 and giving employment to hundreds of thousands.

Its influence has been far reaching. It broke the isolation of the farms, increased the number of business transactions, and speeded the tempo of modern life. Its importance to special industries, such as newspapers, has been of inestimable value. It has tended to break down State lines, to eradicate regional differences, and to increase international contacts. It has been of aid in safety, in transportation, in fighting fires, and crime.

The automobile was just coming into use in 1900, as is illustrated by the newspaper comments of the time commending Theodore Roosevelt for his "characteristic courage," when he rode in an automobile. Thirty-five years later there is one automobile to every five persons in the United States. The automobile has had a profound effect on cities. Just as the railroads caused cities to spring up all over the country, so the automobile is changing them, hurling their population with a centrifugal force outward into the suburbs and drawing into an ever-widening trading area many millions of inhabitants drawn from remoter regions. Thus it has created a new unit of population neither city, town, nor hamlet, for which there is as yet no name, but which is often referred to as a metropolitan area. As the railroad built up the big city, so the truck is helping to build up the small place within the metropolitan area. Some metropolitan areas have many hundreds of different governmental units when one or at least a few would make many economies and produce efficiencies impossible in small units. In addition, the gas engine has brought the industrial revolution to the farm, has been of great aid to the criminal, and has become an engine of death to thousands of the people every year. There is therefore reason to the remark that the inventors of the automobile have had more influence than Caesar, Napoleon, and Genghis Khan.

Most of the present Members of Congress did not go to moving-picture shows as children, for there were none for them to attend. This is probably no matter of regret, but it meant that they had little opportunity to speculate on the future of this industry which today in the United States draws every 10 days patrons equivalent in number to the whole population, a truly marvelous growth within a quarter of a century. This great industry, like that of the telephone and the automobile, has helped to knit the territory together in a psychological sense, for the entire population is now exposed to the same stimuli, which brings them news, tells them the same stories, familiarizes them with the same types of manners and morals and hence opens up a new agency of education and propaganda. Florida sees the same moving pictures as Oregon; the farmer learns better than before the ways of a city. A great new competition for leisure time arose, affecting home, church, and school. It was difficult to foresee these consequences in 1900.

The airplane was not taken seriously at that time. Simon Newcomb, dean of science, wrote in 1903: "May not our mechanicians be ultimately forced to admit that aerial flight is one of that great class of problems with which man can never hope to cope and give up all attempts to grapple with it?" That passengers would be flown across the Atlantic Ocean to Europe was not contemplated. Nor was it envisioned that a thousand enemy airplanes of the bomber type could swoop down on a city and utterly destroy it, with hardly an effective gesture of defense on the part of the helpless inhabitants. Clearly the airplane has brought about changes that affect the functions of both Congress and the Chief Executive.

Other inventions have been developed since the beginning of the century which have influenced public policy less directly, but yet effectively. It is reported that a visitor came to this country recently from the land of Aladdin, who, according to all accounts, possessed a wonderful lamp that could do truly miraculous things such as transporting a person from one city to another on a rug or creating a ship full of jewels. This visitor, though nurtured on tales so stimulating to the imagination, was truly astounded when he saw factories in the United States where a wooden box was turned into a pair of silk stockings, where a lump of coal yielded colors more beautiful than royal purple and perfumes more delicate than attar of roses. Rayon has blurred lines between the social classes, once looked upon as barriers that were beginning to form even in the homeland of Andrew Jackson. Perhaps more impressive, this chemical product with other influences has helped to imperil a cotton kingdom and a textile industry which brought on the industrial revolution, and clothed the world with cotton garments.

The development of the radio, unheralded in 1900, must have appeared equally miraculous to the visitor from the East when he heard a man at the South Pole talking through the air to hundreds of thousands of listeners in continents separated by oceans. The radio broadcast has affected profoundly public policies, since it is an agency of unparalleled power for propaganda. But it has influenced the lives of the people more by bringing them recreation and education with dramatic ease, especially in the relatively isolated farms and villages.

There are other industries built on inventions that have been developed since the beginning of the century. But these six industries based on the telephone, the automobile, the airplane, the motion picture, rayon, and the radio represent great accumulations of capital and give employment to millions, besides having had social influences so vast in number and extent as to be impossible to calculate.

If the Legislators, Governors, and Presidents since the beginning of the century could have foreseen the development of these six great industries and could have anticipated their influence on society and the changes precipitated, they would have been in a much better position for directing the policies of the State. Highways are too narrow. The metropolitan area could have been planned better; much crime could have been prevented. Industries could have been located to greater advantage. The growing inadequacies of small local governments could have been more clearly foreseen, and the transfer of some of their functions to a more capable centralized government would have been facilitated. In hundreds of ways the governments, industries, and individuals could have planned more soundly.

What has been written in the preceding paragraphs is past history. This is 1936 and not 1900. The Nation does not stand on the threshold of a new century. But progress is not confined to calendar arrangement. A new hundred years begins at any time. The question that naturally arises is, Will the second third of the twentieth century see the rise of such great industries based on new inventions as was seen in the first third? There may very well be six equally significant inventions during the next phase of our national growth as in the one just concluded.

For instance, all are agreed that one such invention is the electron tube, said to be the greatest invention of the twentieth century. Its most brilliant form is the photoelectric cell, popularly known as the electric eye. This eye sees everything that the human eye can see and more. It is even said to be able to detect certain types of counterfeit money. It will distinguish colors better than human beings can do. When it is joined with another form of the electron tube, the vacuum tube, it becomes able to act on what it sees. Thus it sees a waitress approaching a door with trays in both hands and at once swings the door open for her to pass. Unlike a human being it does not suffer from fatigue. For instance, in a factory it can watch the tin cans go by on a belt, pick out the defective ones, letting only the good ones go by. This monotonous work can be done without strain for as long hours as the manager wishes. That it will cause unemployment is obvious, but it will also lighten the tasks of the workmen. Indeed it brings the automatic factory and the automatic man one step closer. It may be used to regulate automobile traffic, to measure the density of smoke, to time horse racing, to read, to perform mathematical calculations. Hardly a month passes without some new use of the photo-electric cell being reported. Indeed it will require decades to learn the many things this versatile instrument can do.

There are other . . . new inventions . . . which will carry the Nation on to even greater achievement during the years to come. But it should be remarked here that the changes of the future do not rest wholly on these new inventions. While the six inventions mentioned in previous paragraphs are past history, their social effects are by no means all past. Many of these inventions will continue to precipitate problems of policy for the Congressmen yet to come. The full effects of artificial fibers have not yet been felt. The influence of the airplane has just begun. Even the familiar telephone will have many new and profound effects, when long distance telephoning becomes more widespread, upon the distribution of population between metropolis and smaller city, upon the physical separation of management control from production, upon remote controls in general. The telephone wire may be used to record messages, bulletins, even newspapers in the home and office. Nor are the influences of the very common automobile matters of past history either. The new social and economic unit of population called the metropolitan area so encouraged by the automobile is in its infancy, while the trailer may be destined to change the habits of living and working of vast numbers of the people. . . .

How Scientific Achievements Produce Social Changes

An invention usually affects first the persons using it directly. If it be a producer's goods such as a farm tractor, it means at once the replacement of horses or mules, the purchasing of gasoline, and changes in various other farm practices. If it be a consumer's goods such as an air conditioning unit in a home, it affects the construction and use of the house, but of course the units must be fabricated and hence, for that purpose, factories must be created, marketing machinery set up, etc. All such results are called the primary influences of the new technology.

These primary effects may flow out in different directions. Thus the X-ray is used for purposes of diagnosis in medicine and in dentistry. At the same time it is used in therapy as in the treatment of endocrine glands. It is also used in industry to detect minute flaws in the interior of steel castings or other solid objects. Indeed, manufacturers of the X-ray apparatus have noted some sixty different uses of the X-ray.

Similarly there are many different influences of radio. Some 150 were reported in the study of inventions in Recent Social Trends. Radio waves are used in guiding ships to port, as danger signals when a navigator is in distress, in flying airplanes, in program broadcasting, in point-to-point telephoning, in medicine, and in exterminating parasites.

These primary effects are not all exerted at once. Just as it sometimes requires 30 or 40 inventors working over a long number of years to evolve a complex major invention, and just as it may require hundreds of thousands of improvements spread out over time after the invention has been produced; so it requires a long time for the various uses of an invention to be determined. The phonograph was early used for recording dictation. Only later did it evolve into a musical instrument. Indeed, Edison, the inventor, did not think much of the possibility for the phonograph as a musical instrument, but thought it might have some use as a toy, and for recording the last words of dying persons. One does not yet know what may be the possible uses of the cathode ray.

Each of these primary effects may, in turn, produce derivative effects.

Thus, as the tractor replaces animals on the farms there follows as a derivative influence less need for horse feed, which means that the land used for growing such feed is turned to other uses. This is a secondary effect. As land formerly used for stock feed yields other crops, the quantity is increased of other agricultural products, which tends to lower their prices. These lower prices are, in turn, mirrored in land values, perhaps in demands for tariff protection. Thus, these various derivative influences occasion effects secondary, tertiary, and so on. Each effect follows the other much like links in a chain, except that the succeeding derivative effects become smaller and smaller in influence. The effect of the tractor on lobbying for a higher tariff is very slight in comparison with other forces. A derivative effect in another direction is the stimulation the tractor brings to the cooperative movement in various ways, but especially in the purchase of gasoline.

In general, the first primary effect of an invention is found in (a) the economic practices of production and (b) in the habits of the consumers using the finished product. The economic organization as a whole may be the secondary influence if the technologies concerned are important ones. Thus, the tractor has the influence of making farms larger because on the smaller farms a tractor will not pay. Time is required to purchase additional land and to consolidate farms. In other ways tractors influence the agricultural economic organization. They make the adjustment to a business depression more difficult than in the case of horses and mules, for in a depression it is easier to raise feed than to buy gasoline. The tractor also moves the farmer a bit closer toward specialized commercial farming as contrasted to subsistence farming. Very many of the great inventions following the so-called Industrial Revolution have been machines affecting industrial and economic life, namely, gasoline engines, motors, steamboats, chemical and metallurgical inventions. Very often, then, the first great social institution affected by these changes has been the economic organization.

Later derivative effects impinge on other social institutions, such as family, government, church. Thus, the great economic changes that followed the power inventions modified the organization of the family. Women went to work outside the home. Children were employed in factories. The home gradually lost its economic functions. The father ceased to be much of an employer or manager of household labor, at least in cities and towns. There followed a shift of authority from father and home to industry and State. In cities homes became quite limited as to space. More time was spent outside by the members of the family. In general, then, these changes in industry reacted on the family life.

In a similar way inventions have impinged upon government. In some industries the nature of invention was to encourage monopolistic corporations dealing in services used by a large number of individuals or other corporations. Hence governments took on regulatory functions as in the case of the public utilities. Taxation measures shifted from general property, tariffs, and excises on consumption goods to taxes on personal and corporate incomes and on inheritances. In many other ways the government was forced to extend its functions, as in the case of interstate commerce. City governments, especially, had to assume many more activities than those exercised by counties, where wealth was produced largely on farms without the use of power machines.

Thus, the great inventions which first changed industry produced derivative effects on other social institutions, such as government and the family. Finally these, in turn, have produced still another derivative effect upon social views and political philosophies. The attitude toward the philosophy of laissez faire eventually undergoes change as more and more governmental services are demanded, despite professions of the old faith to the contrary. The philosophy regarding home changes too. It is not so clear under the new conditions of the machine age that woman's place is in the home or that the authority of paternalism in the family is exercised as wisely as it was thought to be in the days of our forefathers. Also attitudes toward recreation and leisure time change, with city conditions and repetitive labor in factories. That these attitudes are so slow to change and are often near the last of the derivative effects of invention may appear surprising. It is true that these new attitudes always appear quite early with some few advanced individuals, leaders, and martyrs. The social philosophies of the mass of citizens do not change so early. Observation seems to indicate that the ideational philosophies hang on, become subjects of reverence, and are in general the last to change in any large way.

In concluding the observations of the way technologies exercises influence, an invention may be likened to a billiard ball, which strikes another ball, which in turn still another, and so on until the force is spent. Changes are started on one institution which impinge on others, and those on still others. There is great variety in these sequences; but in the past in many important cases the change occurred first in the technology, which changed the economic institutions, which in turn changed the social and governmental organizations, which finally changed the social beliefs and philosophies. This conclusion does not preclude, of course, the importance and prevalence of other social forces originating from sources other than invention and following this or other sequences. These are not, however, the subject of this report which deals with technology.

B. MASS PRODUCTION AND SCIENTIFIC MANAGEMENT

Two men did more than any other individuals to originate the ideas and create the methods by which modern technology and men are organized today. These men were Henry Ford and Frederick Winslow Taylor. Although most of us today think we know what mass production is, the first selection, "Mass Production," written by Henry Ford, remains a basic document to which every student of modern technology should return from time to time. Many of the assumptions and methods there discussed are still found in assembly-line production today.

No one has made the points in favor of his great organizational innovation better than Ford himself. The outstanding one, of course, is that mass production has made possible mass consumption; that automobiles, washing machines, refrigerators, and other such aids to living have been made abundantly available to people all over this country and increasingly to those in the rest of the world. Yet some of the assumptions on which mass production is based are today being questioned, as will appear from later selections in this book.

The selection by the "father of scientific management," Frederick W. Taylor, complements that of Henry Ford. At first sight, the excerpts from Taylor's famous paper "The Principles of Scientific Management" may seem to have little place among selections devoted to technology and civilization. Taylor's classic examples of the early application of his principles concern the most primitive kinds of manual labor—a man loading pig iron by hand and shovelers in a steel company. But his approach to these ancient and humble kinds of work illustrates new organizational concepts that are as characteristic of modern industry and as far-reaching in their influence as the assembly line. When Taylor found methods by which a man could reasonably and without undue fatigue handle 47½ tons of pig iron a day instead of 12½ tons, he was making a revolutionary contribution to the modern method of organizing work. He promptly decided that it was inefficient for each man to provide his own shovel and use it for shoveling ore at 30 pounds a shovelful or rice coal at 4 pounds for each shovel. Instead he induced the company to provide eight or ten different shovels suited to the kinds of work being done. All this began a new kind of thinking, the cumulative effect of which has been revolutionary for the organization of both men and machines. Taylor sought not only the "best way" of performing each task and the proper time for every operation, but also the best material, tool, or machine, and the best flow and sequence for the work as a whole.

Taylor's ideas were often misunderstood and frequently misused. He was opposed to a speed-up, and he favored genuine cooperation between management and men and a fair division of the increased profits which his methods made possible. He did not foresee, however, that by greatly increasing the organizational role of management, he was to deprive the worker of participation and initiative in the work process. He made the point that in working out actual methods of scientific management for a specific job, it was frequently those men who had recently worked on the job that provided the ideas and methods, but he did not realize that once these ideas were taken over by management, it often became impossible for other workers to make their own contributions to further progress.

As is to be expected in any great work of innovation, the pendulum has today swung somewhat the other way. Many students of modern factory organization feel that the process of putting all initiative in regard to methods and job design into the hands of engineers and management has gone too far and that the worker himself has more to contribute than is generally assumed under present practices. Likewise, extreme specialization and the breaking down of each job into a few simple repetitive operations is now being reexamined. Not only is this practice criticized because of intrinsic boredom for the individual, but the long-term efficiency of this type of job design is also being challenged. Several of the selections in the following sections comment on these questions either directly or by implication.

Ford carried Taylor's ideas even further by installing the conveyor belt, which mechanically determined not only method—down to the last detail—but the speed of work as well.

Like most innovators, neither Taylor nor Ford—nor their immediate followers—could foresee accurately all the important social and psychological effects of their innovations. Interestingly enough, a good many of these effects were precisely the reverse of Ford's and Taylor's expectations. The fact that these pioneers were less skillful as prophets than as inventors should not blind us to their organizational genius or to their continuing influence on industrial society.

Following the two historical documents of Taylor and Ford is a sharp, modern criticism of both of them entitled "Three Technologics: Size, Measurement, Hierarchy," by Daniel Bell.

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1. THE PRINCIPLES OF SCIENTIFIC MANAGEMENT

From F. W. Taylor, *The Principles of Scientific Management*, Harper & Brothers, New York, 1911, pp. 9–73.

The principal object of management should be to secure the maximum prosperity for the employer, coupled with the maximum prosperity for each employe.

The words "maximum prosperity" are used, in their broad sense, to mean not only large dividends for the company or owner, but the development of every branch of the business to its highest state of excellence, so that the prosperity may be permanent.

In the same way maximum prosperity for each employe means not only higher wages than are usually received by men of his class, but, of more importance still, it also means the development of each man to his state of maximum efficiency, so that he may be able to do, generally speaking, the highest grade of work for which his natural abilities fit him, and it further means giving him, when possible, this class of work to do.

It would seem to be so self-evident that maximum prosperity for the employer, coupled with maximum prosperity for the employe, ought to be the two leading objects of management, that even to state this fact should be unnecessary. And yet there is no question that, throughout the industrial world, a large part of the organization of employers, as well as employes, is for war rather than for peace, and that perhaps the majority on either side do not believe that it is possible so to arrange their mutual relations that their interests become identical.

The majority of these men believe that the fundamental interests of employes and employers are necessarily antagonistic. Scientific management, on the contrary, has for its very foundation the firm conviction that the true interests of the two are one and the same; that prosperity for the employer cannot exist through a long term of years unless it is accompanied by prosperity for the employe, and vice versa; and that it is possible to give the workman what he most wants—high wages—and the employer what he wants—a low labor cost—for his manufactures. . . .

It should also be perfectly clear that the greatest permanent prosperity for the workman, coupled with the greatest prosperity for the employer, can be brought about only when the work of the establishment is done with the smallest combined expenditure of human effort, plus nature's resources, plus the cost of the use of capital in the shape of machines, buildings, etc. Or, to state the same thing in a different way: that the greatest prosperity can exist only as the result of the greatest possible productivity of the men and machines of establishment—that is, when each man and each machine are turning out the largest possible output; because unless your men and machines are daily turning out more work than others around you, it is clear that competition will prevent your paying higher wages to your workmen than are paid to those of your competitor. And what is true as to the possibility of paying high wages in the case of two companies competing close beside one another is also true as to whole districts of the country and even as to nations which are in competition. In a word, that maximum prosperity can exist only as the result of maximum productivity. . . .

Why is it, then, in the face of the self-evident fact that maximum prosperity can exist only as the result of the determined effort of each workman to turn out each day his largest possible day's work, that the great majority of our men are deliberately doing just the opposite, and that even when the men have the best of intentions their work is in most cases far from efficient?

There are three causes for this condition, which may be briefly summarized as:

First. The fallacy, which has from time immemorial been almost universal among workmen, that a material increase in the output of each man or each machine in the trade would result in the end in throwing a large number of men out of work.

Second. The defective systems of management which are in common use, and which make it necessary for each workman to soldier, or work slowly, in order that he may protect his own best interests.

Third. The inefficient rule-of-thumb methods, which are still almost universal in all trades, and in practising which our workmen waste a large part of their effort.

This paper will attempt to show the enormous gains which would result from the substitution by our workmen of scientific for rule-of-thumb methods. . . .

To explain briefly: owing to the fact that the workmen in all of our trades have been taught the details of their work by observation of those immediately around them, there are many different ways in common use for doing the same thing, perhaps forty, fifty, or a hundred ways of doing each act in each trade, and for the same reason there is a great variety in the implements used for each class of work. Now, among the various methods and implements used in each element of each trade there is always one method and one implement which is quicker and better than any of the rest. And this one best method and best implement can only be discovered or developed through a scientific study and analysis of all of the methods and implements in use, together with accurate, minute, motion and time study. This involves the gradual substitution of science for rule of thumb throughout the mechanic arts. . . .

In order that the work may be done in accordance with scientific laws, it is necessary that there shall be a far more equal division of the responsibility between the management and the workmen than exists under any of the ordinary types of management. Those in the management whose duty it is to develop this science should also guide and help the workman in working under it, and should assume a much larger share of the responsibility for results than under usual conditions is assumed by the management.

The body of this paper will make it clear that, to work according to scientific laws, the management must take over and perform much of the work which is now left to the men; almost every act of the workman should be preceded by one or more preparatory acts of the management which enable him to do his work better and quicker than he otherwise could. And each man should daily be taught by and receive the most friendly help from those who are over him, instead of being, at the one extreme, driven or coerced by his bosses, and at the other left to his own unaided devices.

This close, intimate, personal cooperation between the management and the men is of the essence of modern scientific or task management. . . .

Under the old type of management success depends almost entirely upon getting the "initiative" of the workmen, and it is indeed a rare case in which this initiative is really attained. Under scientific management the "initiative" of the workmen (that is, their hard work, their good-will, and their ingenuity) is obtained with absolute uniformity and to a greater extent than is possible under the old system; and in addition to this improvement on the part of the men, the managers assume new burdens, new duties, and responsibilities never dreamed of in the past. The managers assume, for instance, the burden of gathering together all of the traditional knowledge which in the past has been possessed by the workmen and then of classifying, tabulating, and reducing this knowledge to rules, laws, and formulae which are immensely helpful to the workmen in doing their daily work. In addition to developing a science in this way, the management take on three other types of duties which involve new and heavy burdens for themselves.

These new duties are grouped under four heads:

First. They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.

Second. They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.

Third. They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.

Fourth. There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men. . . .

Perhaps the most prominent single element in modern scientific management is the task idea. The work of every workman is full planned out by the management at least one day in advance, and each man receives in most cases complete written instructions, describing in detail the task which he is to accomplish, as well as the means to be used in doing the work. And the work planned in advance in this way constitutes a task which is to be solved, as explained above, not by the workman alone, but in almost all cases by the joint effort of the workmen and the management. This task specifies not only what is to be done but how it is to be done and the exact time allowed for doing it. And whenever the workman succeeds in doing his task right, and within the time limit specified he receives an addition of from 30 per cent to 100 per cent to his ordinary wages. These tasks are carefully planned, so that both good and careful work are called for in their performance, but it should be distinctly understood that in no case is the workman called upon to work at a pace which would be injurious to his health. The task is always so regulated that the man who is well suited to his job will thrive while working at this rate during a long term of years and grow happier and more prosperous, instead of being overworked. Scientific management consists very largely in preparing for and carrying out these tasks. . . .

One of the first pieces of work undertaken by us, when the writer started to introduce scientific management into the Bethlehem Steel Company, was to handle pig iron on task work. The opening of the Spanish War found some 80,000 tons of pig iron placed in small piles in an open field adjoining the works. Prices for pig iron had been so low that it could not be sold at a profit, and it therefore had been stored. With the opening of the Spanish War the price of pig iron rose, and this large accumulation of iron was sold. This gave us a good opportunity to show the workmen, as well as the owners and managers of the works, on a fairly large scale the advantages of task work over the old-fashioned day work and piece work, in doing a very elementary class of work.

The Bethlehem Steel Company had five blast furnaces, the product of which had been handled by a pig-iron gang for many years. This gang, at this time, consisted of about 75 men. They were good, average pig-iron handlers, were under an excellent foreman who himself had been a pig-iron handler, and the work was done, on the whole, about as fast and as cheaply as it was anywhere else at that time.

A railroad switch was run out into the field, right along the edge of the piles of pig iron. An inclined plank was placed against the side of a car, and each man picked up from his pile a pig iron weighing about 92 pounds, walked up the inclined plank and dropped it on the end of the car.

We found that this gang were loading on the average about 12½ long tons per man per day. We were surprised to find, after studying the matter, that a first-class pig-iron handler ought to handle between 47 and 48 long tons per day, instead of 12½ tons. This task seemed to us so very large that we were obliged to go over our work several times before we were absolutely sure that we were right. Once we were sure, however, that 47 tons was a proper day's work for a first-class pig iron handler, the task which faced us as managers under the modern scientific plan was clearly before us. It was our duty to see that the 80,000 tons of pig iron was loaded onto the cars at the rate of 47 tons per man per day, in place of 12½ tons, at which rate the work was then being done. And it was further our duty to see that this work was done without bringing on a strike among the men, without any quarrel with the men, and to see that the men were happier and better contented when loading at the new rate of 47 tons than they were when loading at the old rate of 12½ tons.

Our first step was the scientific selection of the workman. In dealing with workmen under this type of management, it is an inflexible rule to talk to and deal with only one man at a time, since each workman has his own special abilities and limitations, and since we are not dealing with men in masses, but are trying to develop each individual man to his highest state of efficiency and prosperity. Our first step was to find the proper workman to begin with. We therefore carefully watched and studied these 75 men for three or four days, at the end of which time we had picked out four men who appeared to be physically able to handle pig iron at the rate of 47 tons per day. A careful study was then made of each of these men. We looked up their history as far back as practicable and thorough inquiries were made as to the character, habits, and the ambition of each of them. Finally we selected one from among the four as the most likely man to start with. He was a little Pennsylvania Dutchman who had been observed to trot back home for a mile or so after his work in the evening about as fresh as he was when he came trotting down to work in the morning. We found that upon wages of $1.15 a day he had succeeded ın buying a small plot of ground, and that he was engaged in putting up the walls of a little house for himself in the morning before starting to work and at night after leaving. He also had the reputation of being exceedingly "close," that is, of placing a very high value on a dollar. As one man whom we talked to about him said, "A penny looks about the size of a cart-wheel to him." This man we will call Schmidt.

The task before us, then, narrowed itself down to getting Schmidt to handle 47 tons of pig iron per day and making him glad to do it. This was done as follows: Schmidt was called out from among the gang of pig-iron handlers and talked to somewhat in this way:

> "Schmidt, are you a high-priced man?"
>
> "Vell, I don't know vat you mean."
>
> "Oh yes, you do. What I want to know is whether you are high-priced man or not."
>
> "Vell, I don't know vat you mean."
>
> "Oh, come now, you answer my questions. What I want to find out is whether you are a high-priced man or one of these cheap fellows here. What I want to find out is whether you want to earn $1.85 a day or whether you are satisfied with $1.15, just the same as all those cheap fellows are getting."
>
> "Did I vant $1.85 a day? Vas dot a high-priced man? Vell, yes, I vas a high-priced man.". . .
>
> "Well, if you are a high-priced man, you will do exactly as this man tells you to-mororw, from morning till night. When he tells you to pick up a pig and walk, you pick it up and you walk, and when he tells you to sit down and rest, you sit down. You do that right straight through the day. And what's more, no back talk. Now a high-priced man does just what he's told to do, and no back talk. Do you understand that? When this man tells you to walk, you walk; when he tells you to sit down, you sit down, and you don't talk back to him. Now you come on to work

> here to-morrow morning and I'll know before night whether you are really a high-priced man or not.". . .

Schmidt started to work, and all day long, and at regular intervals, was told by the man who stood over him with a watch, "Now pick up a pig and walk. Now sit down and rest. Now walk—now rest," etc. He worked when he was told to work, and rested when he was told to rest, and at half past five in the afternoon had his 47½ tons loaded on the car. And he practically never failed to work at this pace and do the task that was set him during the three years that the writer was at Bethlehem. And throughout this time he averaged a little more than $1.85 per day, whereas before he had never received over $1.15 per day, which was the ruling rate of wages at that time in Bethlehem. That is, he received 60 per cent higher wages than were paid to other men who were not working on task work. One man after another was picked out and trained to handle pig iron at the rate of 47½ tons per day until all of the pig iron was handled at this rate, and the men were receiving 60 per cent more wages than other workmen around them.

The writer has given above a brief description of three of the four elements which constitute the essence of scientific management: first, the careful selection of the workman, and, second and third, the method of first inducing and then training and helping the workman to work according to the scientific method. . . .

Although the reader may be convinced that there is a certain science back of the handling of pig iron, still it is more than likely that he is still skeptical as to the existence of a science for doing other kinds of laboring. . . . For example, the average man would question whether there is much of any science in the work of shoveling. Yet there is but little doubt, if any intelligent reader of this paper were deliberately to set out to find what may be called the foundation of the science of shoveling, that with perhaps 15 to 20 hours of thought and analysis he would be almost sure to have arrived at the essence of this science. . . .

For a first-class shoveler there is a given shovel load at which he will do his biggest day's work. What is this shovel load? Will a first-class man do more work per day with a shovel load of 5 pounds, 10 pounds, 15 pounds, 20, 25, 30, or 40 pounds? Now this is a question which can be answered only through carefully made experiments. By first selecting two or three first-class shovelers, and paying them extra wages for doing trustworthy work, and then gradually varying the shovel load and having all the conditions accompanying the work carefully observed for several weeks by men who were used to experimenting, it was found that a first-class man would do his biggest day's work with a shovel load of about 21 pounds. For instance, that this man would shovel a larger tonnage per day with a

21-pound load than with a 24-pound load or than with an 18-pound load on his shovel. It is, of course, evident that no shoveler can always take a load of exactly 21 pounds on his shovel, but nevertheless, although his load may vary 3 or 4 pounds one way or the other, either below or above the 21 pounds, he will do his biggest day's work when his average for the day is about 21 pounds.

The writer does not wish it to be understood that this is the whole of the art or science of shoveling. There are many other elements, which together go to make up this science. But he wishes to indicate the important effect which this one piece of scientific knowledge has upon the work of shoveling.

At the works of the Bethlehem Steel Company, for example, as a result of this law, instead of allowing each shoveler to select and own his own shovel, it became necessary to provide some 8 to 10 different kinds of shovels, etc., each one appropriate to handling a given type of material; not only so as to enable the men to handle an average load of 21 pounds, but also to adapt the shovel to several other requirements which become perfectly evident when this work is studied as a science. A large shovel tool room was built, in which were stored not only shovels but carefully designed and standardized labor implements of all kinds, such as picks, crowbars, etc. This made it possible to issue to each workman a shovel which would hold a load of 21 pounds of whatever class of material they were to handle: a small shovel for ore, say, or a large one for ashes. Iron ore is one of the heavy materials which are handled in a works of this kind, and rice coal, owing to the fact that it is so slippery on the shovel, is one of the lightest materials. And it was found on studying the rule-of-thumb plan at Bethlehem Steel Company, where each shoveler owned his own shovel, that he would frequently go from shoveling ore, with a load of about 30 pounds per shovel, to handling rice coal, with a load on the same shovel of less than 4 pounds. In the one case, he was so overloaded that it was impossible for him to do a full day's work, and in the other case he was so ridiculously underloaded that it was manifestly impossible to even approximate a day's work.

Briefly, to illustrate some of the other elements which go to make up the science of shoveling, thousands of stop-watch observations were made to study just how quickly a laborer, provided in each case with the proper type of shovel, can push his shovel into the pile of materials and then draw it out properly loaded. These observations were made first when pushing the shovel into the body of the pile. Next when shoveling on a dirt bottom, that is, at the outside edge of the pile, and next with a wooden bottom, and finally with an iron bottom. Again a similar accurate time study was made of the time required to swing the shovel backward and then throw the load for a given horizontal distance, accompanied by a given height. This time study was made for various combinations of distance and height. With data of this sort before him, coupled with the law of endurance described in the case of the pig-iron handlers, it is evident that the man who is directing shovelers can first teach them the exact methods which should be employed to use their strength to the very best advantage, and can then assign them daily tasks which are so just that the workman can each day be sure of earning the large bonus which is paid whenever he successfully performs this task.

There were about 600 shovelers and laborers of this general class in the yard of the Bethlehem Steel Company at this time. These men were scattered in their work over a yard which was, roughly, about two miles long and a half a mile wide. In order that each workman should be given his proper implement and his proper instructions for doing each new job, it was necessary to establish a detailed system for directing men in their work, in place of the old plan of handling them in large groups, or gangs, under a few yard foremen. As each workman came into the works in the morning, he took out of his own special pigeonhole, with his number on the outside, two pieces of paper, one of which stated just what implements he was to get from the tool room and where he was to start to work, and the second of which gave the history of his previous day's work; that is, a statement of the work which he had done, how much he had earned the day before, etc. Many of these men were foreigners and unable to read and write, but they all knew at a glance the essence of this report, because yellow paper showed the man that he had failed to do his full task the day before, and informed him that he had not earned as much as $1.85 per day, and that none but high-priced men would be allowed to stay permanently with this gang. The hope was further expressed that he would earn his full wages on the following day. So that whenever the men received white slips they knew that everything was all right, and whenever they received yellow slips they realized that they must do better or they would be shifted to some other class of work.

Dealing with every workman as a separate individual in this way involved the building of a labor office for the superintendent and clerks who were in charge of this section of the work. In this office every laborer's work was planned out well in advance, and the workmen were all moved from place to place by the clerks with elaborate diagrams or maps of the yard before them, very much as chessmen are moved on a chess-board, a telephone and messenger system having been installed for this purpose. In this way a large amount of the time lost through having too many men in one place and too few in another, and through waiting between jobs, was entirely eliminated. Under the old system the workmen were kept day after day in comparatively large gangs, each under a single foreman, and the gang was apt to remain of pretty nearly the same size whether there was much or little of the particular kind of work on hand which this foreman had under his charge, since each gang had to be kept large enough to handle whatever work in its special line was likely to come along.

When one ceases to deal with men in large gangs or groups, and proceeds to study each workman as an individual, if the workman fails to do his task, some competent teacher should be sent to show him exactly how his work can best be done, to guide, help, and encourage him, and, at the same time, to study his possibilities as a workman. So that, under the plan which individualizes each workman, instead of brutally discharging the man or lowering his wages for failing to make good at once, he is given the time and the help required to make him proficient at his present job, or he is shifted to another class of work for which he is either mentally or physically better suited. . . .

The question which naturally presents itself is whether an elaborate organization of this sort can be made to pay for itself; whether such an organization is not too heavy. This question will best be answered by a statement of the results of the third year of working under this plan.

	Old plan	New plan task work
The number of yard laborers was reduced from between	400 & 600 down to about	140
Average number of tons per man per day	16	59
Average earnings per man per day	$1.15	$1.88
Average cost of handling a ton of 2240 lb.	$0.072	$0.033

And in computing the low cost of $0.033 per ton, the office and toolroom expenses, and the wages of all labor superintendents, foremen, clerks, time-study men, etc. are included.

During the year the total saving of the new plan over the old amounted to $36,417.69, and during the six months following, when all of the work of the yard was on task work, the saving was at the rate of between $75,000 and $80,000 per year. . . .

As another illustration of the value of a scientific study of the motives which influence workmen in their daily work, the loss of ambition and initiative will be cited, which takes place in workmen when they are herded into gangs instead of being treated as separate individuals. A careful analysis had demonstrated the fact that when workmen are herded together in gangs, each man in the gang becomes far less efficient than when his personal ambition is stimulated; that when men work in gangs, their individual efficiency falls almost invariably down to or below the level of the worst man in the gang; and that they are all pulled down instead of being elevated by being herded together. For this reason a general order had been issued in the Bethlehem Steel Works that not more than four men were to be allowed to work in a labor gang without a special permit, signed by the General Superintendent of the works, this special permit to extend for one week only. It was arranged that as far as possible each laborer should be given a separate individual task. As there were about 5000 men at work in the establishment, the General Superintendent had so much to do that there was but little time left for signing these special permits.

After gang work had been by this means broken up, an unusually fine set of ore shovelers had been developed, through careful selection and individual, scientific training. Each of these men was given a separate car to unload each day, and his wages depended upon his own personal work.

2. MASS PRODUCTION

From Henry Ford, "Mass Production," *Encyclopaedia Britannica,* 22d ed., pp. 38–40.

The term mass production is used to describe the modern method by which great quantities of a standardized commodity are manufactured. As commonly employed it is made to refer to the quantity produced, but its primary reference is to method. In several particulars the term is unsatisfactory. Mass production is not merely quantity production, for this may be had with none of the requisites of mass production. Nor is it merely machine production, which also may exist without any resemblance to mass production. Mass production is the focussing upon a manufacturing project of the principles of power, accuracy, economy, system, continuity, speed, and repetition. To interpret these principles, through studies of operation and machine development and their co-ordination, is the conspicuous task of management. The normal result is a productive organization that delivers in continuous quantities a useful commodity of standard material, workmanship and design at minimum cost. The necessary, precedent condition of mass production is a capacity, latent or developed, of *mass consumption,* the ability to absorb large production. The two go together, and in the latter may be traced the reasons for the former. . . .

I. The Principles of Mass Production

As to shop detail, the keyword to mass production is simplicity. Three plain principles underlie it: (a) the planned orderly and continuous progression of the commodity through the shop; (b) the delivery of work instead of leaving it to the workman's initiative to find it; (c) an analysis of operations into their constituent parts. These are distinct but not separate steps; all are involved in the first one. To plan the progress of material from the initial manufacturing operation until its emergence as a finished product involves shop planning on a large scale and the manufacture and delivery of material, tools and parts at various points along the line. To do this successfully with a progressing piece of work means a careful breaking up of the work into the sequence of its "operations." All three fundamentals are involved in the original act of planning a moving line production.

This system is practiced, not only on the final assembly line, but throughout the various arts and trades involved in the completed product. The motor car final assembly line offers an impressive spectacle of hundreds of parts being quickly put together into a going vehicle, but flowing into that are other assembly lines on which each of the hundreds of parts have been fashioned. It may be far down the final assembly line that the springs, for example, appear, and they may seem to be a negligible part of the whole operation. Formerly one artisan would cut, harden, bend and build a spring. In 1939 the making of one leaf of a spring was an operation of apparent complexity, yet was really the ultimate reduction to simplicity of operation.

A Typical Operation Described. For its illustrative value let us trace the course of a spring leaf after it has progressed from iron ore through ingot, bloom and billet stages, and is rolled into strips. (1) Beginning as a strip of steel prepared by the steel mill, it is placed in a punch press for cutting and piercing. The workman puts the strip into press until it hits a stop, then trips the press. The cut-off and pierced piece falls on a belt conveyor which runs along the loading end of a series of heat-treating ovens. (2) A second workman takes the pieces from belt conveyor and places them on conveyor which passes through the furnace (in which temperature is automatically controlled); thence they are deposited at a certain temperature by this conveyor at the unloading end of the furnace. (3) The heated piece is lifted with tongs by a third operator and placed in a bending machine which gives the leaf its proper curve and plunges it in oil, the temperature of which is maintained at a definite degree by apparatus beyond the operator's control. (4) As the bending machine emerges from the oil bath, the same operator removes it to a conveyor that delivers it to an annealing furnace. (5) A fourth operator places the leaf on a conveyor that passes through the annealing furnace. (6) The same workman sends it by conveyor through a water-cooling bath, thence to the spring assembly line.

As a set of springs on the Ford car requires on an average 14 leaves, and

25,000 springs are a normal day's output, this operation must be visualized as employing a great battery of lines similar to the one briefly described.

As all the leaves in a spring are of different length and curve, from the bottom or master leaf to the top leaf, this operation must be visualized as one of many carried on simultaneously by different batteries of machines, each battery working on its own special size. All of these lines, with their various machines and operations, are converging on the point where the leaves are assembled into springs. The leaf whose progress has been described is the simplest one.

The operation proceeds as follows:

(7) A fifth workman removes the leaf from the conveyor on its arrival at assembly line. (8) A sixth workman sprays the arriving leaves with a lubricant. (9) A seventh workman inserts a bolt through leaves assembled as a spring. (10) An eighth workman puts a nut on the bolt and tightens it. (11) A ninth workman puts in the clip bolts and tightens them. (12) A tenth workman inspects the completed spring. (13) He hangs spring on conveyor. (14) Conveyor carries it to loading dock where the eleventh workman removes it.

One workman under the old system could attend the leaf through all these phases, or even make a complete spring, but his production would be limited. Where large quantities of the same article are to be made, the simplest operation may involve the whole time of one man. A one-minute operation will require one man a full day of eight hours to accomplish it on 480 pieces. Now this simple part, a spring leaf, must be identical in strength, finish and curve with millions of others designed to fulfil the same purpose, and this becomes a complicated and delicate procedure requiring automatic machinery, the most accurate measuring devices, pyrometer controls, "go" and "no go" gauges—in fact, the best facilities that can be provided by modern management. The leaf described, which is a minor matter when compared with the whole great process, becomes a major matter when considered by itself; it must have its own supply of material delivered in sufficient quantities at indicated places—for example, steel at 1; heat at 2; power and oil at 3; heat at 5; water at 6; bolts at 7; lubricants at 8; bolts at 9; nuts at 10; clips at 11. In this process the secrets of many arts and trades are employed.

The story of this minor part illustrates what is meant by orderly progression of the article through the shop. It goes to meet other parts of the motor-car which have come from other parts of the plant by similar processes. The story illustrates also what is meant by delivering the work to the workman: every workman's task is prepared for him by some other workman, and delivered to his hand. The third principle also is illustrated —the analysis of a single job into its constituent operations. The simplicity of the part here described should not be permitted to exclude from view the multitude of other operations, ranging from the heaviest forgings to the lightest manipulations in bench assembly of delicate electrical instruments. Some gauge inspections involve measurements to the ten-millionth part of an inch.

The economies arising from this method are obvious. The machinery is constantly in use. It would be economically impossible to maintain all this equipment for the service of men occupied in the entire operation of making springs. Presses, furnaces, bending machines, oil baths would be idle while the workman progressed from operation to operation. Under mass production it is the work, not the man, that progresses from operation to operation. Otherwise use-convenience in the commodity would be lessened, while price-convenience would be destroyed. There is also the economy of reduced inventories, in lapse of time between raw material and finished product. Mass production justifies itself by an economy whose benefits may quickly be transmitted to the purchaser.

II. The Effects of Mass Production

But it is not the history and principle of mass production which provoke the widest discussions; the *effects* of it have been placed under scrutiny. What have been the effects of mass production on society?

1. Beginning with management, where unquestionably mass production methods take their rise, there is a notable increase in industrial control, as distinguished from financial control. The engineer's point of view has gained the ascendancy and this trend will undoubtedly continue until finance becomes the handmaid instead of the mistress of productive industry. Industrial control has been marked by a continuous improvement of the standards, for standardization does not mean stagnation, but the instant adoption of the better method to the exclusion of the old, in the interests of production. Financial control was not, in its heyday, marked by a tendency to make costly changes in the interests of the product. The economy of scrapping old equipment immediately upon the invention of the better equipment was not so well understood. Engineering control, entrenched in mass production methods, brought in this new readiness to advance. Management has been kept close to the shop and has reduced the office to a clearing-house for the shop.

Managers and men, as well as the manufacturing process, have been brought to greater singleness of purpose.

2. The effect of mass production on the product has been to give it the highest standard of quality ever attained in outuput of great quantities. Conditions of mass production require material of the best quality to pass successfully through the operations. The utmost accuracy must control all these operations. Every part must be produced to fit at once into the design for which it is made. In mass production there are no fitters.

The presence of fitters indicates that the parts have been produced unfit for immediate placement in the design. In works of art and luxury this accuracy is achieved at the cost of careful handiwork. To introduce hand methods of obtaining accuracy into mass production would render mass production impossible with any reference to price-convenience. The standard quality of the product is guaranteed by the fact that machines are so constructed that a piece of work cannot go through them unless it exactly accords with specifications. If the work goes through the tools, it must be right. It will thus be seen that the burden of creation is on management in designing and selecting the material which is to be produced by the multiple processes utilized in mass production.

3. The effect of mass production on mechanical science has been to create a wide variety of single-purpose machines which not only group similar operations and perform them in quantity, but also reproduce skill of hand to a marvellous degree. It is not so much the discovery of new principles as the new combination and application of old ones that mark this development. Under mass production the industry of machine making has increased out of all comparison with its previous history, and the constant designing of new machines is a part of the productive work of every great manufacturing institution.

4. The effect of mass production on employees has been variously appraised. Whether the modern corporation is the destruction or salvation of arts and crafts, whether it narrows or broadens opportunity, whether it assists or retards the personal development of the worker, must be determined by observable facts. A cardinal principle of mass production is that hard work, in the old physical sense of laborious burden-bearing, is wasteful. The physical load is lifted off men and placed on machines. The recurrent mental load is shifted from men in production to men in designing. As to the contention that machines thus become the masters of men, it may be said the machines have increased men's mastery of their environment, and that a generation which is ceaselessly scrapping its machines exhibits few indications of mechanical subjection.

The need for skilled artisans and creative genius is greater under mass production than without it. The Ford Motor Company employs more than 15,000 skilled mechanics in the construction and maintenance of the machinery of production, besides other thousands engaged directly in the production of cars. It has been debated whether there is less or more skill as a consequence of mass production.

The present writer's opinion is that there is more. Practical production men assert that mass production requires an increasing degree of mass intelligence.

The common work of the world has always been done by unskilled labour, but the common work of the world in modern times is not as common as it was formerly. In almost every field of labour more knowledge and responsibility are required.

3. THREE TECHNOLOGICS: SIZE, MEASUREMENT, HIERARCHY

From Daniel A. Bell, *The End of Ideology,* Free Press, Glencoe, Ill., 1960.

The contemporary enterprise was set up to obey three peculiar technologics: the logic of size, the logic of "metric" time and the logic of hierarchy. Each of the three, the product of engineering rationality, has imposed on the worker a set of constraints, with which he is forced to wrestle every day. These condition the daily facts of his existence.

For the man whose working day is from eight in the morning to five in the afternoon, the morning begins long before the time he is to arrive at his place of work. After a hasty wash and a quick breakfast, he is off in his car or on the streetcar, bus or subway; often he may have to spend an hour or more in getting to the plant. (There seems to be a law, as Bertrand Russell has noted, that improvements in transportation do not cut down traveling time but merely increase the area over which people have to travel.)

Although this is the most obvious fact about modern work, few writers have concerned themselves with it, or with the underlying assumption: that large masses of human labor should be brought to a common place of work. The engineer believes that concentration is technologically efficient: under one roof there can be brought together the source of power, the raw materials, the parts and the assembly lines. So we find such huge megaliths as Willow Run, now used by General Motors, a sprawling shed spanning an area two-thirds of a mile long and a quarter of a mile wide; or such roofed-over, mile-long pavements as the Boeing plant in Wichita, Kansas.

This belief in the efficacy of size was conditioned by the type of energy first used—the limited amount of power available through the use of steam. Since steam dissipates quickly, the engineer tended to crowd as many productive units as possible along the same shaft, or within the range of steam pressure that could be carried by pipes without losses due to excessive condensation. These considerations led, too, to the bunching of workers in the layout of work, since the machines had to be located along a straight-line shafting.

The introduction of electric power and electric motors opened the way to greater flexibility; and within the plant these opportunities were taken. Newer work-flow designs have avoided the antiquated straight-line shafts and aisles of the older factory. Yet the outward size of the factory remained unchallenged. Why? In part because the engineer conceives of efficiency in technological terms alone; and he is able to do so because a major cost—the travel time of the worker—can be discounted. But the question can be posed: should large masses of persons be brought to a common place of work? Which is cheaper to transport: working men twice daily, or materials and mechanical parts, let us say, twice a week? As Percival and Paul Goodman so pertinently note in their book, *Communities:* "The time of life of a piece of metal is not consumed while it waits for its truck; a piece of metal does not mind being compressed like a sardine." What the Goodmans propose is production in "bits and pieces" rather than integrated assembly. If the plants were located near workers' communities, the men would not have to travel; the processed materials would be brought to several places for manufacture, and the parts would then be collected for assembly. Yet the question is rarely considered, for few industries pay directly for their workers' travel time. Calculations in terms of market costs alone do not force the enterprise to take into account such factors as the time used in going to and from work, or the costs of roads and other transport to the factory site, which are paid for by the employee or by the community as a whole out of taxes.

In his travel to and from work the worker is chained by time. Time rules the work economy, its very rhythms and motions. . . .

One of the prophets of modern work was Frederick W. Taylor, and the stop watch was his bible. If any such social upheaval can ever be attributed to one man, the logic of efficiency as a mode of life is due to him. With "scientific management," as enunciated by Taylor, we pass far beyond the old rough computations of the division of labor; we go into the division of time itself.

The stop watch itself was not new. Before Taylor, work had been timed; but only for the entire job. What Taylor did was to split each job into its component operations and take the time of each. This, in essence, is the whole of scientific management: the systematic analysis and breakdown of work into the smallest mechanical component and the rearrangement of these elements into the most efficient combination. Taylor gave his first lectures to American engineers in 1895 (the year, one might note wryly, that Freud and Breuer published their *Studies in Hysteria,* the "breakthrough" of psychoanalysis). But it was in 1899 that Taylor achieved fame when he taught a Dutchman named Schmidt to shovel 47 tons instead of 12½ tons of pig iron a day. Every detail of the man's job was specified: the size of the shovel, the bite into the pile, the weight of the scoop, the distance to walk, the arc of the swing and the rest periods that Schmidt should take. By systematically varying each factor, Taylor got the optimum amount of barrow load. By exact calculation, he got the correct response.

But Taylor also knew what such a mechanical regimen would do to a man or, rather, what sort of man could fit into this strait jacket. "One of the very first requirements for a man who is fit to handle pig iron as a regular occupation," he wrote, "is that he shall be so stupid and so phlegmatic that he more nearly resembles an ox than any other type." [1]

The logic of Taylorism was obvious: each man's work could be measured by itself; the time in which an operation could be performed could be established "without bargaining" as an impersonal "standard time"; pay could then be computed on the basis of the amount of work done and the time taken to do it.[2] In the modern economy, shading of time is so important (as Benjamin Franklin, the prototype of Max Weber's ethical protestant, remarked, "time is money") that a large company like General Motors contracts with its workers on a six-minute basis. (For purposes of payroll calculation, General Motors divides the hour into ten six-minute periods and, except for the guarantee of three-hours "call-in" pay, the worker is paid by the number of tenths of an hour he works.)

The significance of Taylorism lies in its attempt to enact a social physics. Once work was scientifically plotted, Taylor felt, there could be no disputes about how hard one should work or the pay one should receive for labor. "As reasonably might we insist on bargaining about the time and place of the rising and setting sun," he once said. For a managerial class which at the turn of the century had witnessed the erosion of its old justificatory mystique of "natural rights," the science of administration *per se* provided a new foundation for its moral authority.

While Taylor analyzed the relations of work to time, another engineer, Frank Gilbreth (1868–1924), carried the process one step further: he detached human movement from the person and made of it an abstract visualization. Not only could the pattern of machine work be broken down into elements, but human motion, too, could be "functionalized," and the natural movements of arms and legs could be ordered into a "one best way" of usage.

Gilbreth (whose contemporary fame rests, ironically, on the movie story of the frenetically organized domesticity of his large family, *Cheaper by the Dozen*) isolated eighteen basic patterns of kinetic units or motions, e.g. reach, move, grasp, which he modestly called *therbligs* (or Gilbreth spelled backwards). And, from the analysis of therblig combinations, Gilbreth came to his principles of "motion economy." For example: two hands should not be idle at the same instant except during rest periods; motions of the arms should be in opposite and symmetrical directions, and so on. The penalty for violating these rules is waste.

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[1] Taylor was not the first to understand such consequences. One hundred and fifty years earlier, Adam Smith wrote: "The understandings of the greater part of men are necessarily formed by their ordinary employments. The man whose life is spent in performing a few simple operations . . . has no occasion to exert his understanding. . . . He generally becomes as stupid and ignorant as it is possible for a human creature to become." *The Wealth of Nations* (Modern Library, 1937), p. 734.

[2] Which is why the "protestant" industrial economy cannot adopt the system of "family wage," to be found in Italy and other countries where Catholic social doctrine applies, whereby a man with children receives more wages than the one who has none, though both do the same work.

There was one further step in the exorable logic of rationalization. While Taylor systematized factory operations and Gilbreth sought to reduce waste motion, Charles Bedeaux sought to combine these into a unit measurement of human power, not unsurprisingly called a "B," which would correspond to the "dyn," or the unit in physics of mechanical power. So defined, "a B is a fraction of a minute of work plus a fraction of a minute of rest always aggregating unity but varying in proportion according to the nature of the strain." Using this detailed calculus, Bedeaux formulated a complicated but mathematically neat system of wage payments which took into account not only the work done but the varying fractions of nonwork or rest required in different operations, and increased or decreased payments correspondingly.[3]

The fragmentation of work, although atomizing the worker, also created a dependency and a hierarchy in work, for inherent in the division of labor is what Marx called "the iron law of proportionality." Thus, in the manufacturing process, the ratios between different numbers of workers required in different work processes are ordered by technological complexities. Marx cited an example in type manufacture: One founder could cast 2,000 type an hour, the breaker could break up 4,000 and the polisher could finish 8,000 in the same time; thus to keep one polisher busy the enterprise needed two breakers and four founders, and units were hired or discharged, therefore, in multiples of seven. In many other operations, notably an assembly line, similar inflexible ratios are established, and the hiring and firing of numbers of workers is dictated by the multiples of those ratios. But such dependency presupposes coordination, and with such coordination the multiplication of hierarchies.

The logic of hierarchy, the third of the logics created by modern industry, is, thus, not merely the sociological fact of increased supervision which every complex enterprise demands, but a peculiarly technological imperative. In a simple division of labor, for example, the worker had a large measure of control over his own working conditions, i.e., the set-up and make-ready, the cleaning and repairing of machines, obtaining his own materials, and so on. Under a complex division of labor, these tasks pass out of his control and he must rely on management to see that they are properly done. This dependence extends along the entire process of production. As a result, modern industry has had to devise an entire new managerial superstructure which organizes and directs production. This superstructure draws in all possible brain work away from the shop; everything is centered in the planning and schedule and design departments. And in this new hierarchy there stands a figure known neither to the handicrafts nor to industry in its infancy—the technical employee. With him, the separation of functions becomes complete. The worker at the bottom, attending only to a detail, is divorced from any decision or modification about the product he is working on.

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[3] At the height of its use the Bedeaux system was used in the United States by 720 corporations, employing 675,000 workers. During World War II, charges against Bedeaux of collaboration with Vichy, plus the bitter hostility of the unions to this method of mechanical wage calculations, brought the system into disuse here.

These three logics of size, time and hierarchy converge in that great achievement of industrial technology, the assembly line: the long parallel lines require huge shed space; the detailed breakdown of work imposes a set of mechanically paced and specified motions; the degree of coordination creates new technical, as well as social, hierarchies.[4]

4. NOTE BY THE AUTHOR

Besides the Bell selection, other comments and discussions on the way work is organized today should be explored by the interested reader. For example, the relation of scientific management to organizational theory is admirably discussed in March and Simon, *Organizations,* Chapter 2. For an inquiry like this one, men's assumptions about what they do and why they do it are strategic. For assumptions underlying scientific management and current engineering and managerial practice, the following are especially recommended: *Toward a More Effective Enterprise,* by R. L. Katz, and Douglas McGregor's *The Human Side of Enterprise.* One of the major conclusions which emerges from these and other recent studies of work, organization, and technology is that the Machine has too often been falsely labeled "villain." Many of the harmful human effects—as well as economic wastes and inefficiencies—which stem from traditional ways of organizing men and machines are resultants not of mechanization per se, but of mechanized, or limited assumptions about human nature in its work relationships.

[4] It is remarkable how recent is the assembly line, both as a mode of operation and as a linguistic term. Oliver Evans developed a continuous production line for milling grain in 1800, and the packinghouse industry in the 1870's had adopted the use of overhead conveyors for the processing of slaughtered animals. But the assembly line as a modern achievement owes its success largely to Henry Ford and the establishment of an auto line at Highland Park, Michigan, in 1914. And only in 1933 did the Oxford English Dictionary legitimatize the term when its supplement in that year added the contemporary meaning of the word. See Siegfried Giedion, *Mechanization Takes Command.*

C. REVOLUTION IN THE MACHINE-MAN RELATIONSHIP

The individual feels the influence of technology in the modern world in a hundred ways. Some of these—and perhaps the most pervasive—are indirect, from such features of our industrial life as "big business" and "big government," both of which could not have developed without the support of scores of technical innovations. But here we shall begin to examine the impact of technology on man in the modern world by considering it in its most direct thrust on men at work, as when a worker spends each hour of his working day controlling or being controlled by machines in a modern factory.

For many years this area of study or appraisal was disregarded by both engineers and social scientists with a few exceptions,[1] and it became a field preempted largely by philosophers and propagandists. Many persons who had never been inside a factory denounced all mass-production methods as making robots out of men. On the other hand, industrial management tended to repeat the point of view of Henry Ford, who idealized the human results of the mass-production method.

One of the earliest and most notable exceptions to the speculative or propagandist approach was taken by a professor of psychology, Leon Walther, who in the early 1920s began careful and systematic observations of the relation between the worker and his work in a Swiss watch factory.[2] After World War I a series of unpretentious but thoroughly scholarly studies was made by the British Medical Council. It was this series which inspired Elton Mayo, often regarded as the founder of industrial sociology in the United States, to interest himself in repetitive and paced work in the modern factory. His early essay on the subject, "What Is Monotony?" is still a classic. As the first selection in this section, the essay has the added advantage of summing up for the reader most of the earlier work in this area, especially the admirable series of British Medical Council Studies.[3]

Mayo's paper analyzes the word—and the idea—"monotony," pointing out that a sense of boredom with accompanying mental fatigue derives not only from the objective character of the work, such as tasks requiring repetitive motions, but from the subjective approach of the operator. In short, "What is one man's meat, etc." Nonetheless, by precept and example, Mayo emphasizes the importance of work content in creating or relieving fatigue. The paper contains the now famous experiment with rest pauses conducted in a Philadelphia textile plant, together with a theoretical explanation of its spectacular success.[4]

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[1] In 1908, Max Weber, the German sociologist, initiated a study on the selection and adjustment of workers in large-scale industry which anticipated some of the questions and findings of later students in this field.

[2] Leon Walther, *Psychologie du travail*, Ed. du Mont-Blanc, Geneva, 1947. For a discussion of Walther's contributions in this field, see Georges Friedmann, *Où va le travail humain?* Gallimard, Paris, 1950, pp. 208–224.

[3] "What Is Monotony?" appears as Chap. II in Mayo's book, *The Human Problems of an Industrial Civilization*, The Macmillan Company, New York, 1933. In Chap. I, there is a review of research into the physiology of fatigue and of work, as distinguished from the psychological and social ingredients of human work.

For the most part, Mayo's paper is concerned with the problems of boredom derived from repetition, or "doing the same thing over and over again," in a typical industrial work environment. Many other studies (including the author's) show that an equally important fatigue factor in machine-man relationships is "pacing," or more particularly, the coercion of human rhythm into machine regularities together with a matching of machine speeds.

To illustrate both these fatigue factors, we turn to a composite of excerpts under the general title Pacing and Repetitiveness. The first, called "The Man on the Assembly Line," introduces the subject. The next, "An Assembly-line Worker Looks at His Job," gives the subjective approach of the average worker to all phases of the machine-man relationship. This is followed by "A Quantitative Look at Human Behavior on the Assembly Line," which attempts a quantitative approach to the same relationship. The last two selections are by way of summary and of suggested implications for society and management. "Mass Production and the Individual" discusses the machine's impact on both worker and foreman. This selection argues that, apart from redesigning the technology itself (see Job Enlargement), the evils of overspecialization and pacing at the machine level can be partly removed and mitigated by management, provided it is fully aware of the problem's importance. The final selection, "Management and the Assembly Line," is a challenging discussion of the relation between assembly-line technology and top-management thinking.

The excerpts included in "Pacing and Repetitiveness" were drawn from a series of interrelated studies made over the years by the Technology

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[4] The most famous of all the experiments and studies connected with the name of Elton Mayo is, of course, the so-called "Hawthorne experiment," conducted at a Western Electric Company plant. The conditions and findings of this study, published in full under the title, *Management and the Worker* by Roethlisberger and Dickson, Harvard University Press, Cambridge, Mass., 1939, are so well-known that no part of it is here reproduced. It should be required background reading for most of the sections in this part. Many criticisms of this classic in industrial sociology have been made in the twenty-odd years since its first appearance. An admirable summary and appraisal of these criticisms may be found in Henry A. Landsberger, *Hawthorne Revisited*, Cornell University Press, Ithaca, N.Y., 1958.

Project of Yale University. The highlighting in this research of these two often-neglected themes, pacing and repetitiveness, is the author's only justification for drawing so immodestly on work with which he has been personally associated. The earlier work of the British Industrial Fatigue Research Board and of Elton Mayo offered the Project a firm foundation on which to build. There are comparable findings in two recent studies which are recommended to the reader. The first is "The Worker Speaks His Mind," by Purcell, and the second is "Toward a Democratic Work Process," by Blum. The whole subject is put into an even broader perspective by Georges Friedmann in *Le Travail En Miettes.*

The psychological question of the relation between machine rhythms and human rhythms in the modern world appears to the author to be so important that the next selection is "An Experiment in Worker Control over Pacing." It is reprinted from William F. Whyte's *Money and Motivation* and is one of the few case studies made of the machine-man rhythm relationship in a modern factory. The article also illustrates the significance of worker participation in decision making concerning pacing and other job conditions. Finally, the article dramatizes the fact that any organizational change, unless it fits into the total social structure of the organization, is likely to fail.

In recent years, the man who has perhaps done most in systematic thinking about the intimate relation of men to machines is W. Baldamus, a research scholar at the University of Birmingham in England. Baldamus's main preoccupation is with "satisfactions and interest *inherent in the work*" or the lack of them, which, he contends, have received to date wholly inadequate attention from students of human relations in industry. A central concept in his scheme of thinking is that of the "working mood," an intermediate state between boredom and interest which has been neglected by most students, although it is a very common experience of workers. It is "an adjusted state of mind conducive to the smooth performance of work to which one is accustomed. The mild satisfaction found in the working mood may explain the almost universal initial reluctance of the worker to change conditions and methods of work—his conservatism in contrast to his employer's radicalism in search of more efficient procedures."

Two other concepts developed by Baldamus are striking and useful in thinking about the immediate man-machine relationship. These are "traction," or factors producing in the worker's mind the impression that he is taken along automatically toward completing a task; and "resistance," or factors which he experiences as initiating obstacles which have to be overcome. Both feelings can be present in any one operation—traction reducing and resistance intensifying the feeling of strain. "Both traction and resistance are responses to objective (external) stimuli, namely to specific conditions characteristic of the type of work. . . ."[5]

Baldamus's writings demand rather close study but are rewarding for two reasons. He brings, first of all, a good analytical intelligence to bear on an area of social science that was neglected until recently, and he does this from the man's point of view rather than the production engineer's. Second, he shows, by an examination of absenteeism and turnover rates, that the area is of very real practical interest to management. In one study, turnover was shown to be associated with a high incidence of "strain-increasing factors" in the immediate job—irritation, direct supervision necessary for the job, tedium, and mental fatigue—whereas low turnover was associated with a high incidence of "strain-reducing factors" (e.g., different types of traction). The reader may be interested in applying these concepts to the jobs he reads about in this book, or better still, to others with which he has had personal experience. He should notice when traction can be associated typically or regularly with the technological milieu of a job, and when resistance fits.

What is being done and what can be done about the most practical and pressing problems in this field of machine-man relationship? The approach taken by most managements to problems of low morale due to a monotonous or otherwise unrewarding job content is an indirect one. It is usually assumed that job content at the machine-man level is a "given." It cannot be changed, so the only way to influence the psychological climate of the job is through some form of distraction or *compensation*. Many employers are motivated in the granting of a variety of fringe benefits as morale-building devices and as compensations for work environments which are intrinsically trivial or uninteresting. A number of factories have introduced music to change the feeling tone of workers on routine and repetitive work. A review of these indirect methods—external to the actual machine-man relations—is outside the province of this discussion. Here we shall be concerned only with the direct efforts to alter the technical or social content of factory jobs in the interest of satisfaction for the individual worker or of greater efficiency, or both.

In other times and cultures, the problems we have been discussing were seldom noticed. Routine, monotonous or otherwise unpleasant jobs were often performed by slaves or by persons of low status who had no voice in what they did or in how they were rewarded for doing it. Also, religious and social activities were frequently intermixed with hard or monotonous work, as in the work of monasteries or in the sewing bees, roof-raising festivities, and harvesting contests of pioneer days in the United States.

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[5] W. Baldamus, "Type of Work and Motivation," *British Journal of Sociology*, vol. 2, no. 1, pp. 44–58, March, 1951.

From a cultural point of view, one of the most striking features of modern work is its complete separation from social activities, religion, or art, which together with work make up the lives of normal men and women.

We turn now to direct approaches to solving problems in the contemporary man-machine relationship. The first approach, which has developed rapidly over the past decade, is variously called human engineering, biomechanics, or ergonomics. The field covered by these formidable names has meant, for the most part, research leading to the better adaptation of instruments and machines to their users, either in military or civilian life, and to the intensive study of man's reactions to visual and auditory stimuli. In recent years an important new problem which stems from automation is "perceptual fatigue," caused when work in factories with automatic controls demands much reading of dials and reacting to a variety of signals, on the basis of which the operator must reach quick and important decisions.

Intensive research in perceptual fatigue and similar problems of human engineering is today being carried on at the Applied Psychology Research Unit in Cambridge, England, and by the RAND Corporation in the United States. References to publications in this specialized field will be found at the end of this introduction. Less specialized approaches to the practical problems of job content and machine relationship will now be discussed.

As we saw by looking at two classical documents, Henry Ford on mass production and Taylor on time and motion study, the trend, especially since World War I, has been to reduce the content of workers' jobs to their simplest components and to abstract from them all skill and responsibility. Henry Dennison, the New England manufacturer, remarked many years ago that too often in modern industry "jobs have created themselves out of the demands of mechanics alone and have only accidentally become such that men and women, being what they are, could take any interest or satisfaction in them." Or as Peter Drucker has put it, the worker is used "as a poorly designed, one-purpose machine tool; whereas actually repetition and uniformity are two qualities in which human beings are weakest. In everything but the ability to judge and coordinate, machines can perform better than men." Automation is now showing spectacularly the number of ways machines can perform better than men. But it is also showing that even the automatic factory needs man's ability to judge and coordinate.

It was probably inevitable that the trend of half a century or more during which the jobs of workers had been shrinking in content and skills should cause a reaction, a swing of the pendulum to some degree in the other direction. Significantly that swing began, not because of the preaching of humanitarians or the cries of radicals about turning men into robots, but because practical production men found that it often paid to enlarge the job and so release more responsibility, skill, and judgment to the mass-production worker. All this happened during and after World War II in many manufacturing plants, but there was little conscious realization of its psychological significance. The first systematic application of "job enlargement" as conscious principle and manufacturing policy occurred in the Endicott plant of the International Business Machines Company toward the end of World War II.[6] (See C. R. Walker, "Job Enlargement: Experience at IBM Corporation.") An example, as described by a former manager of the Endicott plant, will give the reader briefly the method and the rationale of job enlargement as then practiced both at IBM plants and elsewhere.[7]

> Based upon our experience in the Endicott plant, we began to apply the principle of job enlargement to the other operating plants in the company. Here is an example of job enlargement in the assembly of the frame for the IBM electric typewriter. Prior to our job enlargement program, a typical sub-assembler might have had the job of simply fastening some parts to a typewriter frame. On down the line the parts would be aligned by a higher paid final assembly man and later on the operation would be checked for accuracy by a process inspector. In the new program, this same typical assembler now aligns as well as fits his parts and checks the accuracy of his alignment. He is now completely responsible for all the operations along his two-yard stretch of the assembly line. To do this, he has had to learn how to read a blue-print showing the electrical wiring and other mechanical insides of the typewriter frame. At the same time he has become a more skilled assembler and he has a job which has become more varied and interesting.

Notice that the enlarged job gives the worker greater variety, and hence is presumably more interesting, but that it also demands greater skill and judgment. The majority of cases of job enlargement reported in the selections that follow were not undertaken as experiments in social science, but were done for strictly practical reasons by cost-conscious managements. Some of the advantages reported were reduced spoilage and number of rejects (due to a greater sense of product responsibility by the individual worker), improved quality, higher morale, reduced absenteeism and turnover, and decreased number of accidents. Not all jobs permit job enlargement, but when they do, certain obstacles must be overcome. The obstacles and limitations of the policy and philosophy of job enlargement as well as its advantages are discussed in the included selections.

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[6] In making the first study of job enlargement in IBM, the author gave that name to the phenomenon as being descriptive of what was actually occurring in the redesign of jobs in the Endicott plant. The name stuck and has been generally applied to the same phenomenon elsewhere.

[7] Danse L. Bibby, "An Enlargement of the Job for the Worker," *Proceedings of the 17th Conference Texas Personnel and Management Associations,* University of Texas, Austin, Tex., Oct. 21–22, 1955, pp. 20–31.

Not only in factories have the principles and practice of job enlargement begun to take root, but in offices for white-collar workers as well. It is possible that it may, in the end, find a wider application here than in the factory. In 1956, the number of white-collar workers in the United States surpassed, for the first time, the number of blue-collar workers.[8] In many offices the number of repetitive and essentially trivial occupations are greater than in factories, and to meet morale problems, and as a cure for low-quality performance and excessive absenteeism, job enlargement has been tried. Examples are given in the selections "White Collar Workers in an Insurance Company" and "White Collar Workers and Supervisors in a Public Utilities Company."

Although we have pointed out the practical business reasons as reported by management for turning to job enlargement, it is obvious that these innovators were moving into a field where the intimate and not too well-understood phenomena of the human personality and nervous system were interacting with the traditional principles and practice of engineering and of plant organization. Some of these deeper implications of job enlargement, as well as the immediate empirical results, are discussed in the selections.

Two points come to mind as one examines the examples given in this section. The first touches automation and the way accelerated mechanization is transforming the content of present-day factory jobs. Will automation someday solve the whole problem by eliminating all repetitive, monotonous jobs in modern industry and substituting interesting and "enlarged" jobs for the few skilled workers left who operate—or maintain—the automatic factory? The short answer to this question is no. The evidence to date suggests that some but not all workers involved are upgraded in skill and responsibility in the automatic factory. A series of cases examined by James Bright[9] suggested the demand for less job skill and responsibility. On the other hand, the selection "Case History in Two Power Plants" in the section Men, Machines, and Organizations: A Reappraisal, gives examples of successful job enlargement under the impact of automation. Apart from such studies on automation it is important to remember that even in a highly developed industrial country like the United States, the automatic sector of industry is likely to continue a great deal smaller in its number of gainfully employed than the nonautomatic sector.

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[8] *Instrumentation and Automation Hearings,* United States Subcommittee on Economic Stabilization of the Joint Economic Committee, 84th Cong., Dec. 12–14, 1956, pp. 177–179.

[9] James Bright, *Automation and Management,* Harvard Business School, Boston, 1958.

The second point is not unrelated to the first. Since a large number of jobs under present technological conditions—or economic circumstances—are not susceptible of enlargement, does this mean that nothing can be done about improving or enriching their job content? Whatever the final answer to this second point, it has already led to discussions of a new theory of job design. In effect, proponents of the theory say: To date, the industrial engineer or the practical production man who designs the jobs of workers in the modern factory is applying engineering principles alone to the man-machine relationship forgetting that man is not governed by the same laws as the machine. So, whether we enlarge a man's job or whatever we do with it, the theory which should guide us must take account of sociological and psychological laws as well as mechanical ones.[10]

In this section we have deliberately narrowed the focus of study to immediate job content and concentrated largely on the immediate man-machine relationship. But everyone knows that the man who works directly with or on a machine is not the only one affected. Obviously, the duties and work experience of the foreman differ according to the machine environment he supervises, and to some degree all who work in the factory are influenced by their technological work environment. Besides, what everyone is paid and how, as well as all of a man's personal relations both at work and leisure, are conditioned by the world of machines. In later sections we consider these wider influences.

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[10] Davis, Canter, and Hoffmann, "Current Job Design Criteria," *Journal of Industrial Engineering*, March–April, 1955.

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1. WHAT IS MONOTONY?

From Elton Mayo, *The Human Problems of an Industrial Civilization,* The Macmillan Company, New York, 1933, pp. 28–54.

Industrial investigation has from the beginning been compelled to recognize that the interferences which operate to prevent sustained work in industry are not merely or mainly organic. An early report, 1924, of the Fatigue Board in discussing the effect of systematically arranged rest-pauses says: "Rest-pauses must clearly be treated from two points of view according to the nature of the work. In muscular work they must be regarded mainly as rests in the literal sense; that is, they serve as recovery periods from the effects of physiological fatigue. On the other hand, in work of which the main feature is repetition rather than effort, boredom and monotony are the factors to be taken into account rather than fatigue, and here the action of the rest-pauses probably depends on change from the main occupation rather than on complete cessation from work. The two problems, therefore, are quite distinct and ought to be studied independently." [1] The problem of monotony as clearly distinct from fatigue owes its definition chiefly to Dr. H. M. Vernon, one of the senior investigators of the original Health of Munition Workers Committee and of the Board. In the year 1924 he published two monographs, one a study of rest-pauses in industry, the other some observations on the effects of variety in repetitive work.[2] Mr. S. Wyatt, who has since developed the study further, was associated with both inquiries. The former of these monographs consists of two studies, the first by Vernon and Bedford, industrial; the second by Wyatt, experimental. The industrial study is thus summarized: "Estimation of the effect of introducing rest-pauses (five to ten minutes) during the work spells is very difficult, because other influences cannot be excluded. . . . However, the rests were followed by a slight but genuine improvement of output in most of the instances investigated, even after making a full allowance for the effect of practice. . . . The rest-pause effect takes several months to reach its full extent."

"Apart from regularized rest-pauses, the workers always get a certain amount of change (a) by taking voluntary rests from work, and (b) owing to the fact that they have to fetch and carry material, and do other jobs which afford relief from the monotony of their chief occupation." [3] Wyatt, as a result of his experimental study uncomplicated by industrial conditions, is more specific. "The objective conditions of modern industry show an increasing tendency to give rise to monotony. This is due to the increased sub-division of labor and amount of repetition work. . . . Although such objective conditions are conducive to increased monotony, the amount of monotony experienced probably depends more on the attitude of the operative towards his work. It is well known that the same industrial task has different subjective effects upon different individuals, and while some may find the work extremely monotonous and at times even intolerable, others find it comparatively pleasant, and prefer it to more varied occupations. Where, however, the work has a subjective sameness and gives rise to monotony, it has an inhibiting effect upon activity."[4] Both Vernon and Wyatt are observing output curves; both find that fatigue is not the only "interference" that diminishes production, monotony is equally effective. "The results of the experiment described in this report suggest that monotonous activities of the type under consideration cause a considerable reduction in output, which is most apparent about the middle of the spell of work. This reduction can be avoided to a certain extent by the introduction of a rest-pause of fifteen minutes' duration half-way through the spell. . . . There is an increase in output not only after the rest, but also before the rest takes place. . . ."[5]

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[1] Industrial Fatigue Research Board, Fourth Annual Report, p. 697.

[2] Industrial Fatigue Research Board, No. 25, H. M. Vernon, T. Bedford, S. Wyatt; No. 26, H. M. Vernon, S. Wyatt, A. D. Ogden.

[3] Industrial Fatigue Research Board, No. 25, p. 19.

Four years later, in 1928, the two Vernons in the course of a study of the effect of hours of work say, "The psychological effects of a rest-pause may be even greater than the physiological, especially for operatives engaged on monotonous repetition work. . . . It is impossible to measure the psychological effect of a rest-pause directly, but indirect evidence was obtained from a study of the labor turnover at three factories where somewhat similar work was performed at similar rates of pay." All the factories were large and well-appointed modern buildings; the weekly hours of work were nearly the same. At Factory B the labor turnover between 1923 and 1925 averaged 25 per cent on the average number of women employed, 42 per cent at Factory A, and 94 per cent at Factory C. "Labor turnover depends on such a number of different factors that it is impossible to argue closely, but it is a suggestive fact that at the factory with the lowest labor turnover the workers were given a fifteen-minute rest-pause in each work spell, during which they went to the canteen, and a free tea was provided for them in the afternoon. In the factory with the intermediate turnover the workers did not leave their places, but had a three-minute pause in which to drink the tea provided by the management, whilst in the factory with the highest turnover no rests at all were allowed, and the workers were discouraged from surreptitious feeding."[6]

Vernon summarizes thus: "The adoption of a rest-pause—with opportunity for refreshment—during work spells of five hours' duration is desirable:

a. for physiological reasons, dependent on the fact that there is often a period of six hours between breakfast and dinner.

b. for psychological reasons, dependent on the relief from monotony."[7]

In 1929 Wyatt published the results of a study done in collaboration with J. A. Fraser of "the effects of monotony." The work reported is in part laboratory experiment and partly also direct industrial inquiry. The industrial study includes a number of different operations, all of them repetitive—winding, tobacco weighing, chocolate packing, soap wrapping. The industrial workers studied differ widely in intelligence. Wyatt's conclusions, briefly put, are that "the experience of boredom is fairly prevalent among operatives employed on repetitive processes," that "boredom causes a reduced rate of working which is particularly noticeable about the middle of the spell," that "boredom also causes a more variable rate of working" and "is responsible for an overestimation of time-intervals," which tends to be associated with a slower rate of working. Once again he finds that "the experience of boredom is largely dependent on individual characteristics and tendencies." Workers of superior intelligence are more easily bored, but are nevertheless "usually above the average in productive efficiency." "Temperamental tendencies are important determinants and need special investigation."

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[4] *Ibid.*, p. 23.

[5] *Ibid.*, p. 34.

[6] Two Studies on Hours of Work, No. 47, Industrial Fatigue Research Board, pp. 3–5.

[7] *Ibid.*, p. 16.

In addition to all this, however, he makes two comments of high interest: "The amount of boredom bears some relation to the degree of mechanization of the task. It is less liable to occur when (a) the work is entirely automatic. In such cases thought can be detached from work and directed to more interesting subjects, or utilized in conversation with other workers. If, however, the mind is not distracted in this manner, boredom can be very intense." Boredom is also less likely (b) "when attention is entirely concentrated on the task. In such cases unexpected and varied situations frequently arise. . . . It (boredom) is most marked in semi-automatic processes which require enough attention to prevent mind-wandering but not enough for the complete absorption of mental activity." These observations can, I think, be extensively confirmed by the experiences of industry in the United States. O. S. Lovekin . . . was interested to discover that some of the lowest and steadiest pulse-products—work with least effort—he encountered were those of young women working on conveyors. His opinion was that in such instances the work was at its automatic maximum and the group cheerfully social.

Wyatt's second interesting conclusion is expressed thus: "The amount of boredom experienced bears some relation to the conditions of work. It is less liable to arise (a) when the form of activity is changed at suitable times within the spell of work, (b) when the operatives are paid according to output produced instead of time worked, (c) when the work is conceived as a series of self-contained tasks rather than as an indefinite and apparently interminable activity, (d) when the operatives are allowed to work in compact social groups rather than as isolated units, and (e) when suitable rests are introduced within the spell of work." [8]

[8] Industrial Fatigue Research Board, No. 56, "The Effects of Monotony in Work," S. Wyatt and J. A. Fraser assisted by F. B. L. Stock, pp. 42, 43.

At this point it is wise to pause for a moment in order to make certain that we do not misunderstand the observations of Vernon and Wyatt. The word "monotony," no less than the word "fatigue" arouses reminiscences in all of us which make it easy for us to assume that there must be a simple fact that corresponds with the word. Because we have ourselves known what it is to be "tired" and "bored," we tend to assume an identity of personal attitude in all the industrial situations where a fall in output is recorded in the middle of a working spell, or a high labor turnover over a period of time. Yet the fall in output and the labor turnover are facts of record; the experience of "boredom" is a highly hypothetical explanation. I say highly hypothetical because it is clear that just as "fatigue" is used to describe a variety of organic incapacities all externally conditioned in a different manner, so also monotony is used to describe a variety of personal situations, differently conditioned. Everything that Vernon and Wyatt say is designed to drive home this caution. Cathcart, writing in 1928, echoes this claim: "Closely allied to fatigue is another phenomenon as obscure and difficult, viz., monotony. What do we really understand by monotony? . . . Who decides what is monotonous? The old adage that 'one man's meat is another man's poison' is true here. There is a large element of the personal equation. An occupation may be perfectly monotonous to one man, arousing only hatred and disgust, whereas another may find it soothing and suitable. And again, what may be found monotonous one day may not be so the next. It varies from individual to individual, and even from time to time in the same individual." [9]

From the observations of Vernon and Wyatt, quoted above, two interesting considerations emerge. First, the capacity to be unfavorably influenced by repetitive work differs between individuals in respect of, for example, what can be tentatively called intelligent endowment and temperament. Second, the social or personal aspect of the particular industrial group affects the situation in some way, and profoundly. Fortunately these two aspects of the study have received capable attention from two investigators of the Fatigue Board; I refer to the work of May Smith and Millais Culpin.

Miss Smith makes her first contribution to the inquiry into the social determinants of individual activity in a far too little-known essay upon "General Psychological Problems Confronting an Investigator" published as early as 1924.[10] Her statement is so excellent that I quote it at some length. "It is more than probable," she says, that a student of industrial conditions "will be confronted with the problems of the general sameness

[9] "The Human Factor in Industry," E. P. Cathcart, Oxford University Press, pp. 31, 32.

[10] Industrial Fatigue Research Board, Fourth Annual Report, pp. 26 ff.

of the work and the effect of this on individual workers. The word most commonly used to describe this sameness is monotony; this is often uncritically assumed to be synonymous with 'repetition of movement' and the reason is not far to seek. The person usually employed in criticizing or describing industrial processes belongs to a class which is unaccustomed to remain long hours at purely repetitive work. When observing workers so employed, he therefore tends to imagine what he would feel like in such a position, to project his own feelings on to the worker, and to stigmatize the process as monotonous. His verdict may or may not be true; its truth or falsity depends on the worker.

"Literally, 'monotonous' means 'one tone'; it suggests absence of change, a flat wash, a dead level, a situation which fails to provide for the person any intellectual stimulus or emotional change. For the realization of change two factors are necessary: (a) an actual objective change; (b) a person who can be affected by it. The most exciting situations would fail to be appreciated as such by certain melancholic individuals. Repetitive processes, therefore, must either be studied as such, or else put in their complete setting, which setting would include, at least, the repetitive work, the varying amount done as the hours go on, the opinion of fellow-workers and the authorities with regard to that work, physiological changes with regard to meals, fatigue, etc., emotional changes . . . and the collective life of the factory. *The total reaction at any given moment will be a reaction to a composite situation which does not remain unchanged. The consciousness of one or other factor of the composite situation varies from person to person and even from time to time in the same person.*" [11]

Miss Smith develops the theme of individual differences with respect to monotony, then returns to her main topic: "The writer had recently to spend some time in two factories doing the same repetitive work; in the one there were many complaints of dullness, in the other none; in the one the majority of faces expressed a dull acquiescence in existence, in the other, the general joy and happiness in the work was obvious. If a study of repetitive work done in these two factories had followed the same lines, the result would have been different. In the one, no one apparently took any interest in the workers, there was no esprit de corps and a general slackness prevailed; to get the week's money was the only interest and that is bound to be a fitful interest. In the other there was not only a real interest in the work, in the accumulation of it as the day wore on, but also a desire to win the approval of the authorities and interest in many social activities binding one to another. *The repetitive work is a thread of the total pattern, but is not the total pattern.*[12]

"Another point of view sometimes overlooked is that there are compensations in many processes, if one studies the worker as a human being and not only as a performer of a repetition process. . . . The adoption of particular machines by particular workers and their dislike of a temporary removal reveal an interest in the machines as such, which an observer when judging the work might easily overlook, but which cannot, without falsifying the account, be omitted.

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[11] *Loc. cit.*, p. 29; italics mine, E. M.

[12] Italics mine, E. M.

"The worker on repetitive processes may be repeating a very limited number of movements, but his emotional life may be quite varied; he has to adjust to superiors, to equals, to subordinates; if he fails to please the first he may find sympathy and support from the others; he has an audience so that even a tyrannical foreman does not exert an unmodified influence. It is difficult to assess a situation which comprises from the point of view of a worker, at least, the sense of injustice resulting from the careless criticisms of a superior, the feeling of support from one's fellow workers' sympathy, the *esprit de corps* in allying with them against the superior, while to certain characters the joy of having a grievance is incalculable. When such situations arise—and they are not rare—the focus of interest would go from the monotony of the work to the emotion aroused." Miss Smith then describes how praise from a superior while arousing another type of emotion may nevertheless similarly move the focus of interest from the repetitive work to the social situation. She continues: "Days vary in length, as every worker knows, and ten hours of one day are shorter than eight or nine of another. *The work remains the same; it is the general situation and the individual emotional changes that vary.*[13] So many descriptions of factory conditions are like skeleton outlines, or those wire reproductions of the correct movements for motion study; they are quite true, but they lack humanity."

"It is not intended to suggest that repetitive work is good in itself; the point is that an investigator of repetitive work will find himself constantly faced with these personal problems which ought not to be neglected. The mechanical point of view is the result of this neglect."

"The point of view which looks upon a person as a kind of extension to a machine is sometimes implicit, even in discussions on intelligence. Those responsible for selecting people sometimes talk as if the problem of selection were merely that of finding out: (a) the degree of intelligence required for a particular job; (b) the person with that degree. While it is probably true that such an adaptation might bring about a more harmonious relationship than where the two did not fit, yet a problem of equal importance is the study of emotional differences. . . . Where the activity concerned involves highly developed attention or a limited set of delicate adjustments, mental conflicts, conscious or unconscious, will be more likely to interfere with the success of the work than where the movements are cruder and the registration of changes less refined. Doubtless, the best thing to do would be to cure the sufferer, but while this is a counsel of perfection it is at least desirable and more possible to direct his activities into channels where a feeling of inefficiency with its attendant depression is not added to the original weakness. Intelligence alone is not the only criterion of success."

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[13] Italics mine, E. M.

Finally Miss Smith returns to the very important question as to the assumptions an industrial investigator should make, the method he should use. "Dr. Cyril Burt has described very aptly in discussing juvenile delinquency what he calls 'multiple determination,' *i.e.* that a particular result is not caused by some one factor operating equally on all people, so that the presence of this factor invariably would produce the same result. Rather is it that there are several factors which together, operating on a particular temperament, will produce the result." [14] It is clear that before we can profitably assess the part played in industrial determinations by something termed "monotony," we need to be accurately informed with respect to (a) external working conditions, (b) the social-personal situation in its relation to the individuals concerned, and (c) individual differences of capacity and temperament.

Millais Culpin and May Smith demonstrated the importance of their method in an inquiry into the incidence of telegraphists' cramp, a report of which was published by the Board in 1927. Dr. Culpin is an authority upon the psychoneuroses and it is probable that the original intention of the study was, at least in part, to discover a simple means of excluding from telegraphic work persons liable to develop the disability. The issue of the investigation proved to have an interest far above this; in effect it illustrates a method by which the different individual "boredoms" may be further analyzed and in some instances resolved.

The method of inquiry is simply described. "To study a subject merely as the doer of a particular piece of work is of little value; the work to the worker is part of a whole, made up of his numerous reactions to situations, real and ideal, over and above his work. Sometimes it is the phantasy life that is of more importance to the individual than the apparent real life. It is clearly impossible to obtain a thorough knowledge of anyone, but *it has proved possible to get the point of view of a subject with sufficient clearness to yield an insight into the relation of the work he does to his general attitude to life.*" [15]

The investigators point out that, whereas it is now comparatively easy to assess by means of "tests" a subject's general intelligence, "there are no reliable objective methods" of determining other important qualities of his personal make-up. They, therefore, use the method of the clinical interview, "reliance has to be placed on the observation and interpretation of a doctor experienced in such work." "The method adopted was somewhat as follows:

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[14] Industrial Fatigue Research Board, Fourth Annual Report, pp. 29–32.

[15] "A Study of Telegraphists' Cramp," Smith, Culpin, and Farmer, Industrial Fatigue Research Board, No. 43, p. 17. Italics mine, E. M.

> i. General observation of the subject (*i.e.* the individual) such as we are all accustomed to make.
>
> ii. Guided by the knowledge of many subjects (individuals), the external behavior and appearance were linked up to the mental state of which they were probably the expression.
>
> iii. By questions framed so as to bring up different situations in life, it was possible to study the subject more fully and accurately, and thereby verify, disprove, or modify the earlier impression.

"It often happened that when once started the subject would give a very detailed personal account of himself, in which case the investigator would not interfere with questions." [16]

In presenting their conclusions, the investigators inquire "why telegraphy should have a 'cramp' when other occupations of an allied nature have not." We would suggest that the exacting nature of the work, the inevitable rigidity of the conditions, the isolation of this one symptom, with its disabling effects, have all operated to concentrate attention into this channel. The type likely to get cramp may have a nervous breakdown in other occupations, but it is also probable that many who break down in telegraphy might carry on more or less efficiently under conditions more amenable to individual requirements. In England telegraphy is a permanent occupation, which to some is one of its attractions; in America there is more mobility of labor and the disease is hardly recognized. As against the advantage of permanence one may have to put the disadvantages of relative immobility.[17]

Telegraphy, then, has a characteristic "cramp" while "other occupations of an allied nature have not." The work is "exacting in nature" and the conditions "rigid"; but while English telegraphists are numerously plagued with the disability, American operators hardly know it. Some difference in the general situation, and not in the nature of the work, serves to bring this about—perhaps the greater "mobility of labor" in the United States in 1926. This is strongly suggestive of (a) a difference in the social industrial situation, and (b) a personal attitude characterized by mental conflict—a desire to retain the permanent job at war with an increasing aversion from the exacting work and the rigid conditions. Perhaps this is a step towards the analysis of at least one type of boredom. . . .

In September, 1923, some of us were asked to undertake an inquiry into working conditions in the mule-spinning department of a textile mill near

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[16] *Loc. cit.*, p. 16; italics mine, E. M.

[17] *Loc. cit.*, p. 36.

Philadelphia, with the object of devising methods of diminishing an exceedingly high labor turnover. This labor turnover was reported to us as being approximately 250 per cent; that is to say, the mill had to "take on" about one hundred piecers every year in order to keep approximately forty working. The difficulty tended to be most acute when the factory was most busily employed and most in need of men. The mill was very well organized; the management was unusually enlightened and humane. Four financial incentive schemes were in operation and were working well in departments other than mule-spinning. The morale and production elsewhere in the mill were satisfactory; the general labor turnover, excluding the mule-spinners, was estimated at five or six per cent. The investigation and its outcome have been fully reported elsewhere.[18] I propose here to recall a few salient features of the situation that disclosed themselves, and to add some exposition of the method of inquiry used, a method which was not fully described in previous reports.

On a first inspection, the conditions of work in the mule-spinning department did not seem noticeably inferior to the conditions of work elsewhere in the plant. The spinners, like the others, worked only five days in the week; on Saturday and Sunday the factory was closed down. The working day was ten hours in length, five hours in the morning and five in the afternoon, with an interval of forty-five minutes for lunch. The work was done in long "alleys" on either side of which a machine head was operating spinning frames. The number of spinning frames operated by each machine head varied from ten to fourteen; all these frames required close watching by the "head-tender" and the "piecers" in charge. The number of piecers in an alley varied according to the type of yarn that was being spun; as a general rule there were two or three. The distance between the terminal frames was approximately thirty-five yards. The work was repetitive; the piecer walked up and down the alley twisting together broken threads. When there was a "run" of inferior yarn the work demanded vigilance and constant movement. The only variation in work was that which occurred when the machine head was stopped in order to "doff" or to replace a spool. Machine "breakdowns" of a minor character were fairly frequent.

The observations of Wyatt and Fraser, quoted above, were published in London in 1929 and accordingly were not available in Philadelphia in 1923. It is interesting, however, even at this distance in time, to look back and see how the conditions of work which had evolved in mule-spinning implied an infraction of every principle these authors state. Mule-spinning was probably, for example, a "semi-automatic process" which required enough attention to be irritating and "not enough for the complete absorption of mental activity." Beyond this, Wyatt says that boredom (interpreted to mean a general down-grade rather than up-grade mental accompaniment to work, a "minus" rather than a "plus") is less liable to arise:

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[18] "Revery and Industrial Fatigue," *Personnel Journal,* Vol. III, No. 8, Dec., 1924.

a. "When the form of activity is changed at suitable intervals within the spell of work." The twisting together of broken threads for hours at a time was only rarely interrupted by "doffing" or a machine breakdown. Neither of these interruptions was in any sense pleasant or a relief. The "carding" operation performed alongside the mules looked more "monotonous" to such external observers as those described by Miss Smith. The carding operative, however, was much better able to work in leisurely fashion, to break off and chat, to vary his day.

b. "When the operatives are paid according to output produced instead of time worked." The spinners were paid a flat-rate wage but were offered a group bonus which up to the time of the inquiry they had never earned. This was one of the incentive schemes, alluded to above, which "worked" satisfactorily elsewhere in the factory but failed completely in the spinning department. The very fact that the bonus had never been earned by the group served to convince them (although, as subsequent developments showed, mistakenly) that an impossible standard had been set. This increased rather than diminished their irritation.

c. "When the work is conceived as a series of self-contained tasks rather than as an indefinite and apparently interminable activity." Various expressions very generally in use amongst the operatives convinced us that they regarded their work as "an indefinite and apparently interminable activity." To which they added forceful epithets.

d. "When the operatives are allowed to work in compact social groups rather than as isolated units." The arrangement and nature of the work precluded any sociability or conversation. Although there were two or three piecers in each alley, they were always remote from each other and isolated, unless emergency, which equally precluded sociability, brought them briefly together.

e. "When suitable rests are introduced within the spell of work." There had been no official rests, few if any unauthorized breaks, and no suggestion of rest-pauses at the time when the inquiry began.

At the beginning of the inquiry there were difficulties of observation owing to the fact that this was merely the latest of many investigations. The men were restless under observation, and the management uneasily aware of this. At this point we were greatly helped by the collaboration of the Graduate Medical School of the University of Pennsylvania in the placing of a small dispensary in the plant with a qualified nurse in charge. This nurse could administer minor remedies or first aid but was permitted also to refer cases to the Polyclinic Hospital in Philadelphia. This was a sufficient reason for her presence, this and the fact that appropriate aid was actually provided for certain individuals in need of medical advice. But the nurse in charge, in addition to her hospital qualifications, was an expert "interviewer." The method she followed was very similar to that described above by Culpin and Smith. She found that the majority of those who visited her were glad to "give a very detailed personal account" of themselves. In all such situations she would listen carefully and would not "interfere with questions." When not occupied in her small office or clinic, she would walk in her uniform through the factory—visiting all departments but giving the greater part of her time to the workers in the spinning department. Any confidences made to her, and they were many, were regarded as inviolable and not communicated to anyone unless professional need arose. In this way she came to know the attitude and personal background of every worker on "the mules" with some detail and intimacy. She thus created a "listening post" of high value to subsequent procedure in the inquiry and, incidentally, became herself something of a social nexus for the group. It was her finding that the reflections or reveries of the workers in the spinning department were uniformly pessimistic. If any one of them was permitted to talk at length, either in the nurse's office or to her in the department, the preoccupations he expressed, whether about himself, his life, his home, or the work, appeared to be almost invariably morbid.

After some discussion of the situation and its probabilities, the management agreed to institute experimentally two or three ten-minute rest-periods in the morning and again in the afternoon for a single team of piecers, constituting about one-third of the total number. In these rest-periods the men were permitted to lie down and were instructed in the best methods of gaining the maximum of muscular relaxation. From the first the men were interested and pleased; they speedily adopted the method of rest which was advised. The experiment seemed to be in some degree successful in the sense that "morale"—whatever that may be—was generally admitted to be improved, certainly by their supervisors and even by the men themselves. This improvement, curiously, extended even to those workers in the department who were not included in the experimental team. The experiment was not really satisfactory, however, at this stage because no measurement of change, or sufficiently objective evidence, was possible. Output records were kept only for the whole group, so any difference of performance of the special team remained unknown.

In October, 1923, however, the management, pleased with the improved condition of the men, decided to extend the rest-period system to include the entire personnel of the spinning department. This had the effect of making the output records significant for the experiment, and from this time on the official daily, weekly, and monthly figures were made available to us. Unfortunately we were never able to secure the departmental records of output for the period prior to October, 1923. All that we know of this period is that the men had never earned a bonus and that the various authorities considered that their best figure for any given month was probably in the neighborhood of 70 per cent.

The first chart shows the daily productivity of the spinning department from October 1, 1923, to June 30, 1924, calculated in terms of efficiency percentage. The actual weight of yarn that is spun does not provide a satisfactory criterion of production, since a thick thread weighs more than a thin one but takes less labor per unit of weight. The Company had therefore devised a scheme by which times were set for the spinning of unit weights of the various types of yarn. The time allowed in each case was experimentally determined, allowance being made for time lost in doffing, machine breakdowns, and so on. The time allowed ranked as 100 per cent and the department was asked to make an average of 75 per cent for the working days in a month in return for the flat-rate wage paid. Beyond this the scheme provided that any month in which the group average exceeded 75 per cent man-hour efficiency on the Company scale, every worker in the group should be paid a percentage addition to his ordinary wage equal to the group percentage in excess of 75. Thus an 80 per cent monthly average would have meant a 5 per cent bonus on his wages to every employee in the department.

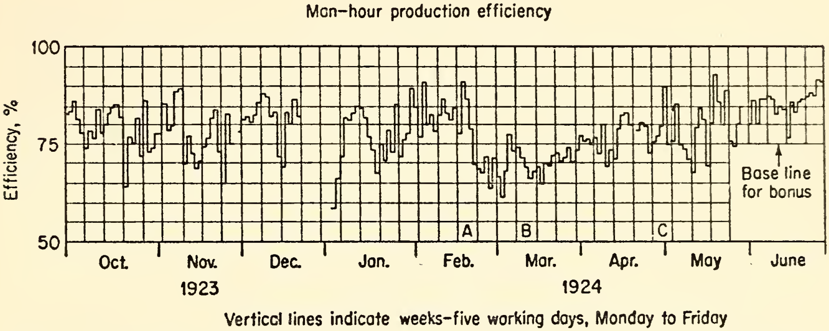

Plate VI. Production—Spinning Mules—Nine Months. (From Elton May, "Revery and Industrial Fatigue," *Journal of Personnel Research*, vol. 3, no. 8, December, 1924.)

The rest-pause innovation was accompanied, from its introduction, by an improvement in the officially recorded productive efficiency. The mental and physical condition of the men was distinctly bettered, their comments to observers were less generally pessimistic than before. Whereas the financial incentive of the bonus had not previously operated to stimulate production, the men now began to be pleased by the fact that they were working less time, earning bonuses as never before, and feeling less tired and irritated. For the first five months of the experiment, the average productive efficiency of the department was 80 per cent, the lowest month was 78¾ per cent, the highest 82.

The system was not, however, altogether satisfactory. It had occurred to someone—not an executive officer—that the rest-period idea might be improved. The men were accordingly made to "earn" their rest-periods. That is, they did not necessarily get a rest at an established time; they were allowed to rest only after completing a certain operation. This meant that they could not always anticipate a definite number of rests at stated periods. On some days, indeed, they might have two rest-periods only. Nevertheless, for the most part they had three or four such intervals in the day and the innovation worked fairly well.

This general condition continued until February 15, when, in response to a heavy demand for deliveries, someone in the factory took it upon himself to order the rest-periods abandoned. (Point marked A on Plate VI.) A week later the carefully built-up improvement in morale had been dissipated and the pessimism had revived in full force. This change was brought to the attention of management and the rest-periods were formally re-instituted. (Plate VI, point B.) Unfortunately the unsatisfactory plan of making the men "earn" their rests was also restored. In March, consequently, the incidence of rest-periods was highly uncertain and irregular. On a given day certain men might have no rests at all; others would have one, two, three, or, rarely, four. In spite of this, the chart shows distinct improvement in the later weeks in March, an improvement which was reflected in a more cheerful mental attitude.

At the end of March the performance of the group showed itself as low —the monthly average had returned to 70 per cent. The president of the Company called a conference and at its conclusion ordered that, during the month of April, the spinning mules should be shut down four times a day for ten minutes at a time, and that all hands from head-tenders to "piecers" should lie down and rest as they had been instructed to do. Adequate floor space and sufficient sacking for comfort created difficulties, because forty men had to lie down simultaneously by their machines. This was contrived, however, and the incidence of rest-periods arranged so that the first ten-minute rest came after two hours' work, the second after work for one hour and a half. This left a concluding work-period in each spell of one hour and ten minutes. The experiment was a success; the figures for April showed a ten per cent improvement over March in spite of the fact that the machines had been shut down while forty men rested for forty minutes every day. In May the president ordered a return to the method of alternating rest-periods, one man at a time in each alley—the alley itself to determine the order of succession. In May the efficiency figure was 80¼, in June 85, July 82, and so on. For the sixteen months after April, 1924, the flat average was 83 per cent—the lowest 79½, the highest 86½. There were other changes of interest. For example, the months when production was highest—September and October, 1924, May and June, 1925—were months in which demand was urgent. The months when production was lower—December, 1924, January, 1925—were months in which work was slack and irregular. Before the innovation in method, the contrary was true. It was also noticed that Monday and Friday were no longer the worst days in the week; again, the performance of a given day tended to relate itself to the demand of that day. The irregularity of daily production observable in May (Plate VI, point C) was due to the fact that, working under the new conditions, the mules were constantly outrunning the carding machines which supplied them with yarn.

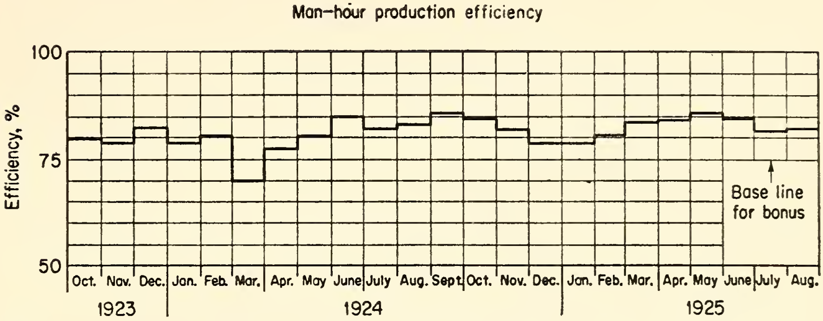

Plate VII. Production—Spinning Mules—Twenty-three Months. (From Elton May, "Revery and Industrial Fatigue," *Journal of Personnel Research*, vol. 3, no. 8, December, 1924.)

The original problem was to devise a method of diminishing a very high labor turnover. In the experimental twelve-month period there was no labor turnover at all. A few workers left the department, one because his family removed to the country, certain others were "laid off" in a slack period. But the problem of an emotional labor turnover ceased to exist. The factory held its workers and had no difficulty in maintaining a full complement even in times of rushed work. The president of the Company in a speech made some years later, claimed that, consequent on the innovation, the labor turnover in the spinning department had fallen from 250 per cent to the steady 5 per cent which was regarded as normal to the whole establishment.

Here, then, is an instance of the manner in which one industrial company worked its way through an acute human problem to a solution very much in accord with the principles later enunciated by Wyatt. At suitable intervals, change was introduced. Payment according to output was to some extent achieved by the consistent earning of bonuses. The work was broken up into self-contained tasks and ceased to be an interminable activity. The social inter-relations within the group improved both within the factory and outside it. Rests were introduced into the spell of work.

Monotony, like fatigue, is a word which is used to denote any sort of induced unbalance in the worker such that he cannot continue work, or can continue only at a lower level of activity. There are many possibilities of such unbalance—different individuals and different situations. Inquiry into such situations looks for some contributing factor or factors in external conditions, something also in the individual himself. The unbalance is, in Cannon's words, both interofective and exterofective; there is a disequilibrium within the individual and between him and his work. In the case cited, the complicating problem was that of the mental preoccupations—pessimism and rage—induced in the workers by the conditions of their work.

2. PACING AND REPETITIVENESS: SELECTIONS OF THE TECHNOLOGY PROJECT, YALE UNIVERSITY

i. The Man on the Assembly Line

> From C. R. Walker, and R. H. Guest, "The Man on the Assembly Line," *Harvard Business Review*, vol. 30, pp. 71–72, May–June, 1952.

> "There are a lot of good things about my job. The pay is good. I've got seniority. The working conditions are pretty good for my type of work. But that's not the whole story. . . . You can't beat the machine. They have you clocked to a fraction of a second. My job is engineered, and the jigs and fixtures are all set out according to specifications. The foreman is an all right guy, but he gets pushed, so he pushes us. The guy on the line has no one to push. You can't fight that iron horse."—*Worker on an assembly line, interviewed by the authors.*

> "Machines alone do not give us mass production. Mass production is achieved by both machines *and* men. And while we have gone a long way toward perfecting our mechanical operations, we have not successfully written into our equation whatever complex factors represent man, the human element."—*Henry Ford II, in a talk before the American Society of Mechanical Engineers, shortly after he was made President of the Ford Motor Company.*

The principal social and psychological problems connected with mass production and human nature have been stated many times and in many different forms. Their importance in an age of advancing technology is hardly in dispute. The question has become rather: What shall we do about them?

Here are a few of the common problems. Since individuals react very differently to industrial occupations, what are the personality characteristics of those who adjust quicklv to—and appear to thrive on—mechanically paced and repetitive jobs? What, on the other hand, are the personality characteristics of those who suffer mentally and physically on such jobs—and who therefore tend to perform them badly? Can the adjustment problem, in other words, be solved by selection? Or is the modern work environment simply *wrong* for the normal human being?

Or to take an engineering and management approach: In the present state of the mechanical arts, what part of a worker's skill and power can the engineer build into a machine? What must he leave out? Precisely how and to what extent in the most mechanized sectors of our economy does the human equation still affect quantity and quality?

Or again, granted that the principles of mass production such as breakdown of jobs into their simplest constituent parts are sound and vital to efficient manufacture, have we yet found how to combine these principles with equally well authenticated principles of human behavior?

Or taking still another approach, if a man spends a third of his life in direct contact with a mass-production environment, why should we not consider important (to him and to society) the hours of living time he spends inside the factory—as important and valuable, for example, as the product he produces which is consumed outside the factory? We talk of a high standard of living, but frequently we mean a high standard of consumption. Man consumes in his leisure, yet fulfills himself not only in his leisure but in his work. Is our mass-production work environment making such fulfillment more difficult?

A short way to sum up these and a great many more questions is: To what degree can—or should—men be "adjusted" to the new environment of machines, and to what degree is it possible to adjust or rebuild that environment to fit the needs and personalities of men?

[To throw light on some of these questions,] the authors undertook . . . an exploratory survey of a modern automobile assembly plant.[1]

ii. An Assembly-line Worker Looks at His Job

From Robert H. Guest, "Men and Machines: An Assembly-line Worker Looks at His Job," *Personnel*, vol. 31, pp. 496–503, May, 1955.

Of all occupations in modern industry none has aroused such controversial comment as has that of the assembly worker, and especially the auto assembly worker on the "final line." The extraordinary ingenuity that has gone into the construction of automobile assembly lines, their perfected synchronization, the "all but human" or "more than human" character of the machines, the miracle of a car rolling off the conveyor each minute under its own power—all this has caught and held the world's imagination for a quarter of a century. On the other hand, the extreme subdivision of labor (the man who puts a nut on a bolt is the symbol) conjoined with the "endlessly moving belt" has made the assembly line the classic symbol of the subjection of man to the machine in our industrial age.

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[1] The full details of this survey are published in book form, *The Man on the Assembly Line*, by the Harvard University Press (June 1952).

General Characteristics of the Mass-production Method

But before considering man in relation to the machine, it would be advisable to define the general characteristics of the mass-production method.

Utilizing the two basic principles of standardization and interchangeability, Ford was able to work out and apply the three following additional "principles" of progressive manufacture:

1. The orderly progression of the product through the shop in a series of planned operations so arranged that the right part always arrives at the right place at the right time.
2. The mechanical delivery of these parts to the operators and the mechanical delivery of the product from the operators, as it is assembled.
3. A breakdown of operations into their simple constituent motions.

The Mass-production Job

Let us now look at these familiar principles or techniques as they are translated into the work experience of individual men and women in mass-production factories. The characteristics of the average mass-production job may be summarized in the following manner:

1. Mechanical pacing of work.
2. Repetitiveness.
3. Minimum skill requirement.
4. Predetermination in the use of tools and techniques.
5. Minute subdivision of product worked on.
6. Surface mental attention.

For the engineer, all the above characteristics are brought into focus in what is known as the *job cycle*. Each worker must perform a prescribed number of operations within a set time limit, and, in the case of those working on moving conveyors, within a given distance along the assembly line.

HOW A TYPICAL ASSEMBLY-LINE WORKER FEELS

With these characteristics in mind, let us go right to a man on the assembly line and see how they affect him; but instead of a statistical summary of the findings from interviews with over 400 assembly-line workers in two plants, excerpts from a single interview will be given here and commented upon insofar as they hold true for the total sample.

The worker whose actual words are quoted below is, like many others, a graduate of a public vocational school in the United States. He is 36 years old and married; he has a couple of children, is buying his own home, and "takes home" just under $80 a week. Here, he is talking to me in his home:

> In 1940 I heard that they were hiring people for the assembly plant. Must have been thousands of fellows lined up for the job. The word got around that they were paying real good money. It was a big outfit, too. No fly-by-night affair.
>
> Figured I'd get any job and then, with a little electrician experience I had in vocational school, I could work my way up to a good job. And the idea of making automobiles sounded like something. Lucky for me, I got a job and was made a spot welder on the front cowling. There wasn't much to the job itself. Picked it up in about a week. Later I was drafted into the Army, and then in 1946 I came back. I tried to get into the Maintenance Department as an electrician, but there was no opening, so I went back to the line—we call it the iron horse. They made me a welder again, and that's what I have been doing ever since.

What His Job Is Like

The worker then went on to describe his job:

> My job is to weld the cowl to the metal underbody. I take a jig off the bench, put it in place and weld the parts together. The jig is all made up and the welds are made in set places along the metal. Exactly twenty-five spots. The line runs according to schedule. Takes me one minute and fifty-two seconds for each job. I walk along the line as it moves. Then I snap the jig off, walk back down the line, throw it on the bench, grab another just in time to start on the next car. The cars differ, but it's practically the same thing. Finish one—then have another one staring me in the face.
>
> I don't like to work on the line—no man likes to work on a moving line. You can't beat the machine. Sure, maybe I can keep it up for an hour, but it's rugged doing it eight hours a day, every day in the week all year long.
>
> During each day I get a chance for a breather ten minutes in the morning, then a half-hour for lunch, then a few minutes in the afternoon. When I'm working there is not much chance to get a breather. Sometimes the line breaks down. When it does we all yell "Whoopee!" As long as the line keeps moving I've got to keep up with it. On a few jobs I know, some fellows can work like hell up the line, then coast. Most jobs you can't do that. If I get ahead maybe ten seconds, the next model has more welds to it, so it takes ten seconds extra. You hardly break even.

> You're always behind. When you get too far behind, you get in a hole—that's what we call it. All hell breaks loose. I get in the next guy's way. The foreman gets sore and they have to rush in a relief man to bail you out.
>
> It's easy for them time study fellows to come down there with a stop watch and figure out just how much you can do in a minute and fifty-two seconds. There are some things they can see and record with their stop watch. But they can't clock how a man feels from one day to the next. Those guys ought to work on the line for a few weeks and maybe they'll feel some things that they never pick up on the stop watch.
>
> I like a job where you feel like you're accomplishing something and doing it right. When everything's laid out for you and the parts are all alike, there's not much you feel you accomplish. The big thing is that steady push of the conveyor—a gigantic machine which I can't control.
>
> You know, it's hard to feel that you are doing a good quality job. There is that constant push at high speed. You may improve after you've done a thing over and over again, but you never reach a point where you can stand back and say, "Boy, I done that one good. That's one car that got built right." If I could do my best I'd get some satisfaction out of working, but I can't do as good work as I know I can do.
>
> My job is all engineered out. The jigs and fixtures are all designed and set out according to specifications. There are a lot of little things you could tell them, but they never ask you. You go by the bible. They have a suggestion system, but the fellows don't use it too much because they're scared that a new way to do it may do one of your buddies out of a job.

Interviewer: "Who do you talk to, Joe, when you're working?"

> There's only three guys close by—me and my partner and a couple of fellows up the line a bit. I talk to my partner quite a lot. We gripe about the job 90 per cent of the time. You don't have time for any real conversation. The guys get along okay—you know the old saying, "misery loves company."

Interviewer: "What sort of a person is your foreman?"

> Oh, I think as a man he is an all right guy. I see him once and a while outside, and he's 100 per cent. But in the shop he can't be. If I was a foreman nobody would like me either. As a foreman, he has to push you all the time to get production out so that somebody above won't push him. But the average guy on the line has no one to push—you can't fight the line. The line pushes you. We sometimes kid about it and say we don't need no foreman. That line is the foreman. Some joke.

The worker then discussed the general working conditions in the plant—the lighting, ventilation, safety conditions, housekeeping, cafeteria facilities, and the plant hospital. He thought these conditions were all good, and that in this respect at least the company had done all it could to make work as pleasant as possible for the workers. Then he added:

> But you know it's a funny thing. These things are all good, but they don't make the job good. It's what you spend most of the time doing that counts.

His Chance of Promotion

The interview then turned to the subject of promotion opportunities:

> My chances for promotion aren't so hot. You see, almost everybody makes the same rate. The jobs have been made so simple that there is not much room to move up from one skill to another. In other places where the jobs aren't broken down this way, the average fellow has something to look forward to. He can go from one step to another right up the ladder. Here, it's possible to make foreman. But none of the guys on the line think there's much chance to go higher than that. To manage a complicated machine like that, you need a college degree. They bring in smart college boys and train them for the better jobs.

Interviewer: "What does your wife think about your job?"
At this point his wife spoke up:

> I often wish he'd get another job. He comes home at night, plops down in a chair, and just sits for about fifteen minutes. I don't know much about what he does at the plant, but it does something to him. Of course, I shouldn't complain. He gets good pay. We've been able to buy a refrigerator and a TV set—a lot of things we couldn't have had otherwise. But sometimes I wonder whether these are more important to us than having Joe get all nervous and tensed up. He snaps at the kids and snaps at me—but he doesn't mean it.

The worker was then asked if he had considered working elsewhere:

> I'll tell you honest. I'm scared to leave. I'm afraid to take the gamble on the outside. I'm not staying because I want to. You see, I'm getting good pay. We live according to the pay I get. It would be tough to change the way we live. With the cost of living what it is, it's too much of a gamble. Then there's another thing. I got good seniority. I take another job and I start from scratch. Comes a depression or something and I'm the first to get knocked off. Also they got a pension plan. I'm thirty-seven and I'd lose that. Course the joker in that pension plan is that most guys out there chasing the line probably won't live 'til they're sixty-five. Sorta trapped—you get what I mean?

His Views on the Union

The subject of the worker's relationship to his union came up in the course of the interview:

> The union has helped somewhat. Before they organized, it was pretty brutal. The bosses played favorites—they kept jacking up the speed of

> the line every time after they had a breakdown. But the union can't do much about the schedule and the way a job is set up. Management is responsible for that.
>
> We had a walk-out last year. They called it an unauthorized strike. Somebody got bounced because he wouldn't keep up his job on the line. The union lost the case because it should have gone through the grievance procedure. The company was dead right to insist that the union file a grievance.
>
> But it was one of those things it's hard to explain. When word got around that the guy was bounced—we all sort of looked at each other, dropped our tools and walked. Somehow that guy was every one of us. The tension on the line had been building up for a long time. We had to blow our top—so we did. We were wrong—the union knew it and so did the company. We stayed out a few hours and back we came. We all felt better, like we got something off our chests.
>
> Some of these strikes you read about may be over wages. Or they may just be unions trying to play politics. But I sometimes think that the thing that will drive a man to lose all that pay is deeper than wages. Maybe other guys feel like we did the day we walked out.

Toward the end of the interview, the worker spoke of the company he worked for:

> They are doing what they can—like the hospital, the safety, the pay and all like that. And the people who run the plant I guess are pretty good guys themselves. But sometimes I think that the company doesn't think much of the individual. If they did they wouldn't have a production line like that one. You're just a number to them. They number the stock and they number you. There's a different feeling in this kind of a plant. It's like a kid who goes up to a grown man and starts talking to him. There doesn't seem to be a friendly feeling. Here a man is just so much horsepower. You're just a cog in the wheel.

Let's just take this interview apart for a moment.

Notice, first, that this worker's dissatisfaction was not due primarily to the things that are usually considered important to a job. People often say, "Pay a man enough and he'll be satisfied." But this man's pay was good. His job was secure. He worked for a sound company. He had substantial seniority. He had a pension, hospitalization and disability benefits when he became sick, and a good boss; at least he did not hold the kind of job he had against the boss. Working conditions, heating, lighting, cafeteria facilities, and safety conditions were, I would say, as good as if not better than average.

Yet Joe despised his job.

The simple fact is that the impact of "sound" engineering principles had had a marked effect on his total outlook on the job.

What "Sound" Engineering Has Taken Away

For this man, and for hundreds of others with whom we have had experience, the engineer, in applying the principles of mass production to the extreme, had factored out virtually everything that might be of real, personal value to the worker. The sense of anonymity implicit in much of what this particular worker said can be traced back to some of the basic characteristics of his immediate job.

The conveyor belt determined the *pace* at which he worked. He had no control over his pace.

Because it was broken down into the simplest motions possible, the job was highly *repetitive.*

Simple motions meant that there was little or no need for *skill.*

The tools and the work procedure were predetermined. And when techniques changed, it was the engineer—not the worker—who controlled the change.

He worked on a *fraction of the product* and never got a sense of the whole. (He admitted that in 12 years of work he had almost never seen a finished car roll off the final line.)

Some attention was required. Too much to allow him to daydream or carry on any sustained conversation with others; but not enough to allow him to become really absorbed in his work.

The technical setup determined the character of his work relationships. This man identified himself with the partner who worked with him on the opposite side of the line, but beyond that he displayed almost no identification with a work group as such. Men on the line work as an aggregate of individuals with each man performing his operation more or less independently of the others. The lack of an intimate group awareness appeared to reinforce the same sense of anonymity fostered by the conveyor-paced, repetitive character of the job itself.

The worker's comments about promotion and job aspirations are interesting. He saw little hope for advancement because most of the production jobs paid about the same. By applying principles of work rationalization, the industrial engineer, in the best interests of efficiency, had simplified the tasks so that differences in skill from one job to the next were all but eliminated. It was difficult for the average worker to move vertically through a series of distinct steps in promotion. In this connection, it should be added that over the years the union itself, through collective bargaining, had encouraged the trend toward uniform wage standards by raising minimum levels without increasing the relative amounts between job classes.

From a careful examination of the actual work careers of over two hundred workers we have found only a few who had experienced any substantial change in job classification during a period of from 12 to 15 years. Collectively, all the workers had improved their over-all economic status; individually, few had experienced much change in their relative job status. The net effect of this condition was to increase the de-personalization of the job.

iii. A Quantitative Look at Human Behavior on the Assembly Line

From C. R. Walker and R. H. Guest, *The Man on the Assembly Line*, Harvard University Press, Cambridge, Mass., 1952, pp. 115–122.

Mass production characteristics appear to have strongly influenced the worker's *attitude* toward his job, and in a majority of instances influenced his attitude unfavorably. But did these characteristics influence or determine actual *behavior?* Is there valid evidence that a worker on a job which has extreme mass production characteristics acts any differently (whatever he may *say*) from a worker on a job without them? Every investigator of human behavior knows the importance of the distinction made, a distinction between verbalizations of emotion and the same emotion resulting in action. Similarly, every factory manager knows the crucial difference between a "gripe" and the overt act of walking off the job. Griping is often referred to by military men as an "inalienable right of the American soldier." Experience shows that the heavy griper is not necessarily a bad soldier—or an inefficient worker. For these and other reasons, we have sought evidence of behavioral correlations with mass production characteristics.

Indirect evidence may be found in the grievance record at Plant X. A substantial number of workers filed grievances centering on "job standards," that is, on questions relating directly to number of operations, mechanical pacing, and other mass production characteristics. There were many more such grievances than there were in the commoner complaint areas of wages or seniority. Thus workers *acted* through the grievance machinery in response to certain charactereristics of their jobs which they said they disliked.

Certain studies in English factories [1] have shown that extreme repetitiveness reduces the productivity of the individual worker. He produces more when there is some measure of variety in his job. Is it possible, then, to relate the productivity of workers in Plant X to repetitiveness, mechanical pacing, and so forth? In our opinion, no. Individual productivity in American automobile assembly operations, under present conditions, is not measured with any degree of accuracy. Rather, it is common practice to set merely a minimum standard, after which the conveyor wholly determines the pace, and hence the productivity, of the worker. Accordingly, we have rejected variations in productivity as a measure of overt behavior.

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[1] S. Wyatt and J. A. Fraser, *The Effects of Monotony in Work, A Preliminary Inquiry*, Industrial Fatigue Research Board, Report no. 56 (London: His Majesty's Stationery Office, 1929). Other relevant British reports issued by the board are Vernon and Wyatt, *The Extent and Effects of Variety in Repetitive Work*, Report no. 26 (1929), and Wyatt and Fraser, *The Comparative Effects of Variety and Uniformity in Work*, Report no. 52 (1928). These studies had been preceded by a large number of industrial reports upon physiological fatigue as related to productivity conducted by the British Government during the First World War.

There remain, however, two important ways of "behaving" which commonly indicate how a worker feels about his job. He can stay away periodically, or he can quit the job altogether. In figures collected by the Bureau of Labor Statistics for automobile assembly plants, there is sufficient data, in our opinion, for the general hypothesis of a connection between mass production jobs and a high quit rate. For such plants,[2] the number of employees (per 100) who quit in 1949 was higher than for any of the other forty-one durable goods manufacturing industries listed.[3] The rate was 2.7 as compared with an average of 1.5 for the other durable goods manufacturing industries.[4]

With these facts in mind, we sought in the present study to analyze the record of quits for Plant X. A breakdown of the quit records for production and non-production workers revealed a significant relationship between the kinds of work men performed and their overt behavior. In the January–June 1949 period, the number of employees (per 100) who quit was almost twice as high (3.0) among *production* workers (that is, men on the assembly line) as among *non-production* workers (1.6), those performing maintenance, stock, salvage, and other *non*-mass production jobs.

We then focused on our immediate sample of production workers. Two types of rating scales were clearly called for if possible correlations were to be sought: one for absenteeism, and one for job characteristics suitable for application to all workers in our sample. Did we have sufficient data to construct such scales? After a thorough study of the company's absentee records and of all job characteristics as reflected in our interviews, we concluded that we did. Scales were then constructed as follows.

Each worker's record was studied for the year 1949. Notations were made as to the number of times a worker was late, the number of days absent, and the reasons given. Then a simple rating scale was developed wherein one point was given for a single lateness, two points for being absent one or two days because of "illness," and three points for absences for which "no reason" was given.[5] Then each worker was scored. The results for our sample of 180 showed a range from zero, those with a perfect record for the year, to thirty-six, an extremely poor record. Median scores fell between six and seven points.

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[2] Recorded in the Bureau of Labor Statistics as the "motor vehicles, bodies and trailer industry," as distinguished from the "motor vehicle parts and accessories industry."

[3] "Monthly Labor Turn-Over Rates (Per 100 Employees) in Selected Groups and Industries," Table B-2, *Monthly Labor Review*, vols. 68–70.

[4] The rate was also higher than for any one of the non-durable goods industries and for any one of the nonmanufacturing industries (except copper mining) in the country during this period.

The rating scale for job characteristics was somewhat more complex, but not difficult to construct. Consider the typical characteristic, repetitiveness. It was obvious that a range in the degree of repetitiveness obtained for any given job. A single-operation job is highly repetitive; a ten-operation job is considerably less repetitive. Similarly, a range between extremes is discernible in other mass production job characteristics. In the characteristic, mechanical pacing, for example, a job on the main line is generally more strictly paced than a job on a sub-assembly line, and a job on a sub-assembly line more than a "bank building" job. It was found possible to work out a three-point range for six typical mass production job factors, with *0* representing the greatest embodiment of the mass production characteristic, 2 representing the least embodiment, and *1* representing a mean point between the two.

The following factors were chosen and scaled: (1) degree of repetitiveness; (2) degree of mechanical pacing; (3) skill as measured by length of learning time; (4) frequency of break in job routine; (5) frequency of social interaction; and (6) size of interacting group.

A word of explanation on the choice of the six factors: They were chosen [because they are] most susceptible to a quantitative expression of range. Notice that the first three, repetitiveness, mechanical pacing, and minimum skill (as measured by learning time), are the first three of the familiar six characteristics which have been employed throughout this book. The fourth, frequency of break in job routine, was found as our study progressed to be generally mentioned by our sample as one gauge of the desirability or undesirability of a job at Plant X. No man, of course, can leave a strictly paced conveyor job for any purpose—to go to the toilet, get a drink of water, or take a "breather"—without signaling for and obtaining a relief man. As a consequence, on strictly paced jobs there was often a low frequency in "breaks." The fifth and sixth factors, frequency of interaction and size of interacting group, are included as measures of the amount permitted or the restriction imposed upon social interaction by mass production techniques.[6]

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[5] A single and a two-day absence due to sickness were given the same scoring, two points. Consecutive sickness absences beyond two days were not counted. The employment and medical departments maintained a thorough system of checking on extended illnesses. Since our interest was in willful absence not accounted for by sickness, the above point system was adopted to minimize absenteeism due to sickness. Also not scored were leaves of absence for illness or for other excused reasons and absences of union officers when on official business. A somewhat similar weighting system was used by John B. Fox and Jerome F. Scott in their study of East Coast metal-working shops (*Absenteeism: Management's Problem*, Harvard Research Studies No. 29, Cambridge, Harvard University Bureau of Business Research, 1943).

Using the above factors, for any one worker a score of zero to twelve was possible. Take, for example, a man's job where every one of the six factors appeared in its most extreme form. Thus, if a man's work pace was determined solely by the moving conveyor, if he performed only one operation, if his learning time was less than one week, if he could rarely "take a break," if he had little actual and little potential interaction with other workers, his total score was the sum of all the zeros, or zero. If, on the other hand, the job factors were the least extreme, several operations not on a moving conveyor, a considerable learning time period, frequent break in routine, frequent interaction, a larger work group, a score of twelve was possible. The median score for all workers fell between five and six points.

TABLE 11. ABSENTEEISM RELATED TO JOB FACTORS
(175 Workers) [a]

	Below median job factor store (0–5 points)	Above median job factor score (6–12 points)	Total [b]
Lower than Median Absentee Record (0–6 points)	35	54	89
Higher than Median Absentee Record (7 or more points)	54	32	86
Total [b]	89	86	175

[a] Records on full sample of 180 were not available.

[b] Line and column totals do not divide exactly at the median of 175. In each case the nearest point score figure to the median was used.

Having constructed these two scales for 175 workers,[7] we studied the relationship of one to the other. The result is shown in Table 11. The first vertical column (Below Median Job Factor Score) represents those workers who had jobs with the more extreme mass production characteristics. Notice that the great majority of this group of eighty-nine had the poorer absentee record. The second column represents those workers who had jobs with less extreme mass production characteristics. Here a reverse tendency is shown. Of the eighty-six in the total, only thirty-two were absent more than average, while fifty-four had a good absentee record.

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[6] There were, the reader may remember, three other characteristics included in our original six—predetermination of tools and techniques, minute subdivision of the product worked on, and surface attention. As to predetermination, this characteristic applies with little variation to all jobs on a final assembly line, and for that reason it is not included as a range factor in our rating scale. As to subdivision of product worked on and surface mental attention, our data were insufficient to establish a range for these factors.

[7] Records on full sample of 180 were incomplete.

Using the standard chi square test of association, it was found that $x^2 = 9.71$ at the one degree of freedom level. The probability (P) of the figures given in this table occurring by chance is less than one in 100. Thus a clear association between absenteeism and mass production characteristics was found. Men with highly repetitive jobs, conveyor paced, and so forth, were far more likely to take time off from work than those whose jobs did not contain such job characteristics.

Further reinforcement of the tie between behavior and mass production characteristics was found when turnover records were examined. Among our sample of 175 workers, twenty-two men had voluntarily quit work at Plant X between 1949 and 1951. These do not include men who had left for medical reasons, military or medical leaves of absences, those who had died, or those who had been laid off because of reduction in operations. An additional four had been discharged for disciplinary reasons.

Of the twenty-two men, fourteen had lower than median scores on the job factors described above. Eight with above median job factor scores had left Plant X. Of the four who had been discharged, three had below and one had above median scores. The average for the sample in job factor points was 5.80. The average score for those who had left was 4.53.

These are small figures on which to base an assumption about the relationship between the nature of a worker's immediate job and his chances of ending his employment. Yet a tendency is suggested. It is to be noted that almost twice the number of workers who had less desirable job factors left work as compared with workers whose job factors were favorable.

SUMMARY

1. This chapter seeks to answer the question: Is there any correlation between mass production characteristics and overt human behavior?

2. The hypothesis that such a correlation exists is suggested by the fact that the quit rate for assembly plants in the automobile industry is higher than for all manufacturing industries and for all but one nonmanufacturing industry.

3. It was found possible to score production jobs at Plant X in terms of job factors indicating which jobs had mass production characteristics in their most extreme form, which in their least extreme form, and which

occupied a middle range. It was also possible out of Plant X records to construct an absenteeism score for each worker.

4. By comparing scores, a correlation was found to exist between absenteeism and mass production characteristics. Workers whose jobs showed "a high mass production score" were absent more often than workers whose jobs had a low mass production score.

5. Quit records for our sample showed that nearly twice as many workers left the jobs with extreme mass production characteristics as left jobs with moderate mass production characteristics.

Thus there were strong indications that mass production characteristics at Plant X had been reflected, not simply in attitude and opinion, but in overt behavior.

iv. Mass Production and the Individual

From C. R. Walker et al., *The Foreman on the Assembly Line,* Harvard University Press, Cambridge, Mass., 1956, pp. 121–125.

The problem of the individual who loses his identity in the mass is a typical problem of the modern world. There is much talk of our huge overgrown institutions, of governments that are bureaucratic because they are too big, of corporations that are impersonal because their operations are so large. Historians and editorial writers indeed have long been busy recording and deprecating the submergence of the individual in the mass. David Riesman's vivid phrase, "The lonely crowd," perhaps sums up the phenomenon and the reaction to it which most of us acknowledge. But on the assembly line this problem has a special character and origin. It is rooted not so much in the circumstance of large-scale operations as in the formal logic of job design, and job design as related to a moving conveyor. . . . As far as engineering ingenuity can devise, individual skill, judgment, and initiative have been subtracted from jobs at the production level. This [can be] illustrated by many examples. Consider only five which particularly emphasize the effect on the individual.

1. The number of units of work performed in any given moment of time is determined by the speed of the conveyor. Accordingly, in doing his job the individual must subordinate his own natural rhythm to the unvarying rhythm of the machine.

2. For the application of human ingenuity or of personal choice in doing his job, or of experience and judgment, a series of simplified motions are substituted and repeated throughout the working day.

3. The exigencies of the moving line compel the strict regulation of relief. In attending to bodily and other personal needs, the worker must

conform to a schedule, and be dependent on a system of organized relief. Rigid conformity to this relief system serves continually to remind the worker of the primacy of the mechanical.

4. There are fewer opportunities for interpersonal relationships than in less rationalized factories. As a result many workers feel a frustrating sense of anonymity.

5. Since there is comparatively little difference in skill between one job and the next, the difference in pay and prestige is small. As a result the average worker feels his chances of promotion are slim, unless he ceases to be a production worker altogether, and becomes a foreman.

To meet all of these and other elements in the work environment that tend to reinforce a sense of the impersonal, and that seem, according to some workers, to swallow up the individual in the mass, the good foreman provides as many counterweights as he can.

In any organization the function of the front-line leader is to mediate between the rigidities and impersonalities of command and the infinite variety of human nature. In assembly lines, the advanced sectors of a rationalized and standardized economy, technology affects the individual as an added force, and a very impressive one, on the side of the impersonal, of the *de*-individualized, of the *non*-human. Those who experience compulsions which are non-human or mechanical are apt to accuse the agents of these compulsions of themselves being inhuman. Hence, the obsessive hostility sometimes exhibited by assembly workers toward corporation managements.[1]

Thus the greater part of the foreman's activity in relation to his men may be looked upon as a spontaneous effort to supply the component indispensable for a successful organization—dignity of the individual.

In the light of this record of the foreman's own efforts to solve the problem, what can the upper ranks of management, including top corporation management, do to assist him? Our answers would be:

1. Give priority in choosing foremen to those who have the skills which enable them to counterbalance anonymity with a personal relationship, to absorb excessive pressures, and to exhibit other characteristics of successful foremen. . . .

2. See that the foreman, apart from his technical duties, has the *time* to establish such personal relationships, either by giving him less to do, or by teaching him to organize his time more effectively, or both.

3. See that there is sufficient continuity of employment of the work force so that more sustained and satisfactory relationships between men and supervision can develop.

4. See that all above the rank of foremen act toward them as the best foremen act toward their men, and especially see to it that the pressure

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[1] See *The Man on the Assembly Line,* pp. 137–140.

from above is never so great as to transform the foreman from a leader into a driver.

We have considered the impact of assembly-line technology on the individual worker. What about its impact on the foreman as an individual? In certain ways this effect appears as the reverse of that on the worker. At the root of the worker's objection to assembly-line technology are the pacing and repetitiveness inherent in his job.[2] It is necessary for the foreman too, in his own way, to "keep up with the line," but far from "doing the same thing over and over," the essence of the foreman's job is doing something *different* every minute. In fact the typical foreman engaged in some four to six hundred *separate* episodes in the course of his working day. If the conveyor kept the average worker at or near one work station doing the same thing, it kept the foreman, on the other hand, moving rapidly from place to place and doing many different things.

This contrast deserves emphasis because it illustrates how any one characteristic of a job, if pushed to an extreme, is repugnant to the normal personality and causes excessive fatigue. Extreme routine on a job is unpleasant and unduly fatiguing to most, if not to all, persons.[3] Excessive discontinuity, an interruption every minute of the day, for example, also is unpleasant and very fatiguing to most people. And in this case both extremes stem directly from the technology of the same work environment.

It is obvious that nearly all supervisory and executive jobs are characterized to some degree by discontinuity and by the pressure of unwanted interruptions. But as in other instances, the technology of the assembly line appears to produce a far more extreme manifestation of a familiar phenomenon. For this reason, just as tests have been suggested to measure workers' limits of tolerance to *routine*, so it would be advisable also to test limits of tolerance to *discontinuity* in the working day.

The foreman, like any good executive, needs the ability to hold simultaneously in his mind details of many incompleted actions, so that later, at the appropriate moment, he may close the episode. He needs the ability to tolerate arbitrary interruptions without forgetting about what he was doing at the moment and without losing his sense of proportion. This suggests a solution on two fronts: (1) careful selection and promotion based on a candidate's ability to withstand interruptions with a minimum of frustration; and (2) alteration wherever possible of conditions which produce excessive interruptions. . . .

Tolerance of routine or of overspecialization, tolerance of discontinuity, or arbitrary interruptions, are phrases which obviously have connotations for our time far beyond that of assembly lines, or even of modern industry as a whole.

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[2] *The Man on the Assembly Line*, pp. 51–56.

[3] *The Man on the Assembly Line*, p. 53.

v. Management and the Assembly Line

From A. N. Turner, "Management and the Assembly Line," *Harvard Business Review*, vol. 33, pp. 47–48, September–October, 1955.

The policies and practices which management adopts necessarily grow out of a certain way of thinking about technology and human relations. For example, whether management tries to help foremen counteract some of the pressure and impersonality associated with the assembly line will depend on its interpretation of the cause of these problems and its judgment as to whether they are undesirable and need to be counteracted. When management itself is thoroughly involved with a particular technology, and committed to its basic concepts, it is difficult to see what the human implications of that technology may be. There is a natural temptation for managers to carry over into their thinking about human motivation the assumptions that seem to underlie the assembly line technology.

Work Simplification

Consider, for example, the assumptions which underlie the traditional principles of work simplification. If it is true that work gets done most efficiently when every job is made as simple as possible and motions are highly repetitive, does it not follow that workers in general are content with uninteresting work and actually shun the additional responsibility of more complex jobs? Some members of management, in order to rationalize to themselves the nature of mass production work, go so far as to believe sincerely that this is the case.

The trouble with such assumptions is that, *even if true* (which is extremely doubtful in view of all the evidence), they are not useful guides to action.[1] What about the worker who is not "average"? Even more important, what are the *results* of such assumptions in supervisory behavior and company policy?

The management which believes that workers dislike responsibility does not try to give it to them. And if management assumes that workers like repetitive jobs, it is not likely to support experiments to make the work more interesting or challenging. Consequently, workers tend to feel that management does not *want* them to take responsibility and does not *expect* them to have an interest in their work; for workers, like everyone else, often behave according to how they think other people want and expect them to behave. The very fact that they feel this way creates a problem, whether they would in fact have responded to more interesting jobs or not. The vicious circle of attitudes can only be broken, I am convinced, when management boldly acts on new, positive assumptions about workers' capacity and willingness to take a real interest in their jobs.

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[1] For more detailed presentation of such evidence, the reader is referred to the subsequent selections on job enlargement in this section. C.R.W.

Power of Coercion

Much the same basic problem exists in relation to mechanical pacing and pressure. The assembly line is primarily an efficient method of moving work in process. But in management's thinking it frequently becomes much more than this. It becomes the agency that gets the work done in the time allowed. Now, if this is assumed, some important further assumptions follow. For example, in order to justify the coercion of the line it is difficult not to assume that by and large people fail to work well unless they *are* coerced. Perhaps no manager would endorse this assumption stated so baldly, but is there not an inevitable danger that it will follow in his thinking, at least subconsciously, if he holds to the first belief?

Admittedly, the moving line has something to do with compelling the completion of each job in a predetermined time. And sometimes certain people *do* have to be coerced in order to do good work, just as under certain (exceptional) circumstances some people prefer repetitive jobs. But basically the cause-and-effect relationship is the other way around. As one manager said:

> People say, "The men start working as soon as the line starts." It should be the other way around. It should be, "The line starts when the people start to work." It's some sort of reverse thinking that everyone gets into, that motivation is mechanical and not human. You don't carry that kind of thinking over when you talk about your car. There you realize that the car won't go unless the human wants it to go. *But on the assembly line people get their thinking mixed up.*

Perhaps this executive was overstating the case. However, he clearly recognized the danger that assembly line technology may tempt management to make certain questionable assumptions about human motivations and capacities. Even if one believes that these assumptions are statistically verifiable, morally right, or socially acceptable, he should still look askance at them. What about the *consequences* of them? If he holds them, how is he likely to act, and how will his actions affect other people? In short, how do they work out in practice?

Let us look at the matter from a pragmatic point of view. These negative assumptions can lead to a serious loss of potential. A management that justifies minute subdivision of the task into its simplest component parts, on the ground that many men prefer repetitive and relatively meaningless jobs, will not benefit from a release of creative interest in the job. Similarly, a management that emphasizes the coercive element in the moving line, on the ground that no one works effectively without externally imposed pressure, will not find the improved productivity that comes from people working hard because they want to and because they participate in setting the goals which are to be reached.

The foreman who gives his men the benefit of the doubt, who is willing to assume that his men want to and are able to do well and that their interest can be stimulated, gets the best results in the long run. But to do so he requires a great deal of support from his superiors and from the total management organization. That is why it is so important for the influence of assembly line technology to be consciously, purposefully counteracted. Otherwise negative assumptions about human ability and motivation may become unthinkingly accepted by managers down the line.

3. AN EXPERIMENT IN WORKER CONTROL OVER PACING[1]

From William F. Whyte, *Money and Motivation*, Harper & Brothers, New York, 1955, pp. 90–96.

This is the story of an experiment that failed because it succeeded too well.

The Hovey and Beard Company manufactured wooden toys of various kinds: wooden animals, pull toys, and the like. One part of the manufacturing process involved spraying paint on the partially assembled toys and hanging them on moving hooks which carried them through a drying oven. This operation, staffed entirely by girls, was plagued by absenteeism, turnover, and low morale.

A consultant, working with the foreman in charge, "solved" the problem. But the changes that were made in order to solve it had such repercussions in other parts of the plant that the company abandoned the new procedures, despite their obvious benefits to production in that local area.

THE PROBLEM

Let us look briefly at the painting operation in which the problem occurred.

The toys were cut, sanded, and partially assembled in the wood room. Then they were dipped into shellac, following which they were painted. The toys were predominantly two-colored; a few were made in more than two colors. Each color required an additional trip through the paint room.

Shortly before the troubles began, the painting operation had been reengineered so that the eight girls who did the painting sat in a line by an endless chain of hooks. These hooks were in continuous motion, past the line of girls and into a long horizontal oven. Each girl sat at her own painting booth so designed as to carry away fumes and to backstop excess paint. The girl would take a toy from the tray beside her, position it in a jig inside the painting cubicle, spray on the color according to a pattern, then release the toy and hang it on the hook passing by. The rate at which the hooks moved had been calculated by the engineers so that each girl, when fully trained, would be able to hang a painted toy on each hook before it passed beyond her reach.

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[1] This chapter was written by George Strauss, based upon information furnished him by the consultant in the story, Alex Bavelas. The consultant also reviewed and revised the chapter.

The girls working in the paint room were on a group bonus plan. Since the operation was new to them, they were receiving a learning bonus which decreased by regular amounts each month. The learning bonus was scheduled to vanish in six months, by which time it was expected that they would be on their own—that is, able to meet the standard and to earn a group bonus when they exceeded it.

By the second month of the training period trouble had developed. The girls learned more slowly than had been anticipated, and it began to look as though their production would stabilize far below what was planned for. Many of the hooks were going by empty. The girls complained that they were going by too fast, and that the time-study man had set the rates wrong. A few girls quit and had to be replaced with new girls, which further aggravated the learning problem. The team spirit that the management had expected to develop automatically through the group bonus was not in evidence except as an expression of what the engineers called "resistance." One girl whom the group regarded as its leader (and the management regarded as the ringleader) was outspoken in making the various complaints of the group to the foreman. The complaints had all the variety customary in such instances of generalized frustration: the job was a messy one, the hooks moved too fast, the incentive pay was not being correctly calculated, and anyway it was too hot working so close to the drying oven.

INTRODUCING THE NEW APPROACH

The consultant who was brought into this picture worked entirely with and through the foreman. After many conversations with him, the foreman felt that the first step should be to get the girls together for a general discussion of the working conditions—something, incidentally, which was far from his mind originally and which in his own words would only have been "begging for trouble." He took this step with some hesitation, but he took it on his own volition.

The first meeting, held immediately after the shift was over at four o'clock in the afternoon, was attended by all eight girls. They voiced the same complaints again: the hooks went by too fast, the job was too dirty, the room was hot and poorly ventilated. For some reason it was this last item that they complained of most. The foreman promised to discuss the problem of ventilation and temperature with the engineers, and he scheduled a second meeting to report back to the girls. In the next few days the foreman had several talks with the engineers, and it seemed that the girls' cynical predictions about what the engineers would say were going to be borne out. They and the superintendent felt that this was really a trumped-up complaint, and that the expense of any effective corrective measure would be prohibitively high. (They were thinking of some form of air conditioning.)

The foreman came to the second meeting with some apprehensions. The girls, however, did not seem to be much put out, perhaps because they had a proposal of their own to make. They felt that if several large fans were set up so as to circulate the air around their feet, they would be much more comfortable. After some discussion the foreman agreed that the idea might be tried out. (Immediately after the meeting, he confided to the consultant that he probably shouldn't have committed himself to this expense on his own initiative; also, he felt that the fans wouldn't help much anyway.) The foreman and the consultant discussed the question of the fans with the superintendent, and three large propeller-type fans were purchased. The decision was reached without much difficulty, since it seemed that the fans could be used elsewhere after their expected failure to provide relief in the paint room.

The fans were brought in. The girls were jubilant. For several days the fans were moved about in various positions until they were placed to the satisfaction of the group. Whatever the actual efficiency of these fans, one thing was clear: the girls were completely satisfied with the results, and relations between them and the foreman improved visibly.

The foreman, after this encouraging episode, decided that further meetings might also be profitable. He asked the girls if they would like to meet and discuss other aspects of the work situation. The girls were eager to do this.[2] The meeting was held, and the discussion quickly centered on the speed of the hooks. The girls maintained that the time-study men had set them at an unreasonably fast speed and that they would never be able to reach the goal of filling enough of them to make a bonus.

The turning point of the discussion came when the group's leader frankly explained that the point wasn't that they couldn't work fast enough to keep up with the hooks, but that they couldn't work at that pace all day long. The foreman explored the point. The girls were unanimous in their opinion that they could keep up with the belt for short periods if they wanted to. But they didn't want to because if they showed that they could do this for short periods they would be expected to do it all day long. The meeting ended with an unprecedented request: "Let us adjust the speed of the belt faster or slower depending on how we feel." The foreman, understandably startled, agreed to discuss this with the superintendent and the engineers.

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[2] These subsequent meetings were effective largely because of the reduced tension and the good will engendered by the original discussions.

The engineers' reaction naturally was that the girls' suggestion was heresy. Only after several meetings was it granted grudgingly that there was in reality some latitude within which variations in the speed of the hooks would not affect the finished product. After considerable argument and many dire prophecies by the engineers, it was agreed to try out the girls' idea.

With great misgivings, the foreman had a control with a dial marked "low, medium, fast" installed at the booth of the group leader; she could now adjust the speed of the belt anywhere between the lower and upper limits that the engineers had set. The girls were delighted, and spent many lunch hours deciding how the speed of the belt should be varied from hour to hour throughout the day.

Within a week the pattern had settled down to one in which the first half hour of the shift was run on what the girls called medium speed (a dial setting slightly above the point marked "medium"). The next two and one-half hours were run at high speed; the half hour before lunch and the half hour after lunch were run at low speed. The rest of the afternoon was run at high speed with the exception of the last forty-five minutes of the shift, which was run at medium.

In view of the girls' reports of satisfaction and ease in their work, it is interesting to note that the constant speed at which the engineers had originally set the belt was slightly below medium on the dial of the control that had been given the girls. The average speed at which the girls were running the belt was on the high side of the dial. Few if any empty hooks entered the oven, and inspection showed no increase of rejects from the paint room.

Production increased, and within three weeks (some two months before the scheduled ending of the learning bonus) the girls were operating at 30 to 50 per cent above the level that had been expected under the original arrangement. Naturally the girl's earnings were correspondingly higher than anticipated. They were collecting their base pay, a considerable piece-rate bonus, and the learning bonus which, it will be remembered, had been set to decrease with time and not as a function of current productivity. (This arrangement, which had been selected by the management in order to prevent being taken advantage of by the girls during the learning period, now became a real embarrassment.)

The girls were earning more now than many skilled workers in other parts of the plant. Management was besieged by demands that this inequity be taken care of. With growing irritation between superintendent and foreman, engineers and foreman, superintendent and engineers, the situation came to a head when the superintendent without consultation arbitrarily revoked the learning bonus and returned the painting operation to its original status: the hooks moved again at their constant, time-studied designated speed, production dropped again, and within a month all but two of the eight girls had quit. The foreman himself stayed on for several months, but, feeling aggrieved, then left for another job.

ANALYSIS OF SUCCESS AND FAILURE

It is not difficult to understand why installing the fans and permitting the speed of the hooks to be controlled by them should have affected the girls the way it did. *No normal person is happy in a situation which he cannot control to some extent.* [Italics added.] The fans may not have actually changed the heat or the humidity, but they were a visible and daily reminder that worker ideas were given consideration.

About the speed of the hooks an additional observation may be made. *The idea that efficient work results from proceeding at a constant rate derives certainly from the operations of machines and not from the characteristic operation of human beings. If anything is clear about human performance it is that it is characterized by changes of pace.* [Italics added.] Some production operations by their nature permit little variation in this respect, but even when the possibility exists it is not readily perceived by many engineers as a source of increased efficiency. From the operator's point of view, to be paced unvaryingly by a machine which he may not even shut down with impunity may be psychologically uncomfortable. In such a situation the only avenue left for the expression of any independence is that of complaint: the machine or its master, the engineer, must be shown to be wrong. Also, there appear to be inherent and unconscious defensive mechanisms which operate against the threat of being "stretched out."

Control over the speed of the hooks in this situation not only allowed changes of pace which were in themselves restful and refreshing, but also allowed the operator the natural enjoyment of operating at top speed without fear that he might be compelled to stay there. Of course, the manner in which the change was instituted was significant. The opportunity to exercise initiative, the gratification of being listened to seriously, helped to bring about changes in the emotional overtones of the situation which were in themselves favorable to increased effort.

In the light of all this it is not suprising that the situation fell apart so completely when the management retrogressed. And the management's action, while it may not have been wise, was certainly an understandable response to what had become an uncomfortable situation. Along with improved production in the paint room had come a host of embarrassments. The extra production in the paint room had created a pile-up in front and a vacuum behind, and both results were unwelcome to the adjoining departments. The wage structure of the plant had been shaken. The prestige of the engineers had suffered, and some of the prerogatives of management were apparently being taken over by employees.

It is clear from this instance that *local* improvements can often be obtained by the methods described here; but it is also clear that they may not lead to benefits for the enterprise as a whole. Changes in one part of an integrated organization may require widespread changes elsewhere, and the cost of such readjustments may far outbalance the benefits received in the local situation.

The changes made in the paint room implied over-all managerial attitude and philosophy that were not in fact present. This being the case, there was no conceptual or philosophic resource for dealing with the eventual implications of what had been done in the paint room. The management neither expected nor was ready to make the kind of changes that seemed necessary. It would have been far better if the consultant had done with the relevant management group what he had done with the foreman in the initial discussions, so that there would have been some shared understanding of the long-range implications of the moves. In a real sense, the superintendent was justified in feeling that the foreman and the consultant between them had put him on the spot. True, his assent to the changes had been secured, but the consultant had not been sufficiently concerned with his genuine understanding of the possible consequences.

The factory is a social system, made up of mutually dependent parts. A drastic change in one part of the system—even a change that is viewed as highly successful within that part—may give rise to conflict reactions from other parts of the system. It may then be dangerous for management to try a new approach in one small part of the system unless it is prepared to extend this approach to the whole organization.

4. JOB ENLARGEMENT

i. Experience at IBM Corporation

From C. R. Walker, "The Problem of the Repetitive Job," *Harvard Business Review,* vol. 28, no. 3, pp. 54–58, May, 1950.

Henry Dennison, the manufacturer, remarked many years ago that too often in modern industry "jobs have created themselves out of the demands of mechanics alone and have only accidentally become such that men or women, being what they are, could take any interest or satisfaction in them."

Since that remark was made, the "case" of the repetitive worker year by year has been attracting serious study. Ever since World War I, for example, both in Great Britain and in the United States there has been a growing body of scientific inquiry by experts into the field of fatigue from work. Within industry a variety of devices have been tried for the relief of monotony in highly simplified repetitive operations, such as frequent transfer between jobs, introduction of rest pauses, music in the workshop, the grouping of workers into competitive teams, and so forth. All have had a measure of success, both in increasing output and in job satisfaction. But only recently has there been what might be called a head-on attack on the problem through actually enlarging and enriching the basic content of the jobs, so that, to repeat Dennison's words, "men or women, being what they are, could take an interest or satisfaction in them."

An obstacle to such experimentation has doubtless been the sacrosanct character of certain engineering assumptions. One of these is that the more subdivided each operator's job, the lower the plant cost and the greater the output. Many factory managers, however, have been discovering that a law of diminishing returns applies to the subdivision of operations, and to many other areas of extreme specialization. For example, no matter how accurate the machines, operators who are bored do not turn out a high-quality product. Also, a large overhead is required by excessively specialized and mechanized departments.

The trouble is that many managements, despite the alterations in factory practice they have been led to make because of this law of diminishing returns, are not aware of the social and human implications of what they have done. For that reason, this article is devoted largely to the experience of one company which made such alterations consciously and with awareness of the implications for its workers. The story can be briefly described as an experiment in the human possibilities of machine operators. The exercise of greater skills by several hundred factory workmen under a deliberate plan of "job enlargement" resulted in a marked rise in over-all factory efficiency and an increase in personal satisfaction for each of the participants.

Policy of "Job Enlargement"

Six years ago the International Business Machines Corporation began this experiment, initiating it in the Parts Manufacturing Department of its Endicott plant and then extending it until it became a company-wide practice and policy. The impetus for initiating the plan came from the chairman of the board (at that time, president of the company), who in the first instance suggested it and then argued the plan's practicability with plant managers. The company frankly hoped for a number of benefits, both organizational and technical, from what it came to call "job enlargement." To begin with, it was hopeful of the "morale building" possibilities of the experiment. Here are a few typical comments of some members of the plant management on this point:

> All the operator did was to put in his part, start the machine, shut it off, take out the part—a monotonous and uninteresting job. We have found a way to make that job more interesting. [A Vice President]
>
> If you take part of a job away from a man, he says to himself, "Why have they done that to me? Don't they think I can do it?" He resents the loss, takes less interest in the company. Conversely, if you give a man more of a job to do, he says to himself, "They must think I'm good," and he takes more interest in the company. [A Plant Executive]
>
> The men are usually unhappy about "nonresponsible," repetitive jobs. We have had several cases where they couldn't "take it" and have had to be transferred to other jobs. On the other hand, girls we find more commonly like the jobs where they can do the same thing over and over again and have no responsibility. Why? They are earning good money and most of them look forward in a year or two to getting married. . . . All normal men, even those without great abilities, prefer, I believe, jobs which have *some* skill and significance attached to them. [The Assistant Superintendent most immediately concerned with initiation of the program]
>
> The operator was merely a cog. We had long been studying ways to give him more satisfaction *on the job.* [Another Assistant Superintendent]

The idea of enriching the job in variety, interest, and significance was thus a conscious motivation. This motivation also suggests that in certain ways the experiment was a development from previous company policy. Plant management had long made a practice of teaching workers the significance of particular operations in the total productive process. This was done even on minute, repetitive, assembly jobs, where the worker was taught how to perform not only his own job but also several related jobs, not in order to do them but to "get a better understanding" and to "take more interest" in the total sequence of operations.

Job enlargement also fitted in with another company policy, continuous education of its personnel. The more skilled and responsible and well paid a worker, management had long argued, the less likely was it that that company would lose his services and have to bear the cost of retraining a new employee.

Installation of Plan

With these policies in the background, the company undertook to study systematically the possibilities of job enlargement first in one department and then throughout the entire company. The following moves were made, it should be noted, under war conditions when the cost of what might be called indirect supervision was at an all-time high.

The jobs in the manufacturing departments before the change were strictly those of machine operators. A part was lifted by the worker and placed in the machine. The machine was started; a cutting tool or drill did the job on the part. The machine was stopped by the operator and the part removed. All preparatory work was done by others; the machine was set up by a specially trained setup man, and the tools sharpened by other specialists. Also, when the job was completed, the part was checked by inspectors who did nothing else. Many of the operators had been at their jobs for years and had acquired the skill and the ambition to make their own setups and checkups, but they were not permitted to do so because this was considered an inefficient method of operating the shop. Others were either novices or old hands who had acquired an "operator psychology" and either felt themselves unable to take responsibility for setup and inspection or preferred not to do so.

The department in which the job enlargement plan was first installed was equipped with the following machines: drill presses, vertical and horizontal millers, broaching machines, automatic screw machines, lathes, grinders. The job of operator on these machines, of course, requires a minimum measure of skill. Such jobs are not equivalent to the simplest of mass-production jobs like those on an automobile assembly line. A few weeks' training in machine manipulation is required.

The initial phase of the job enlargement program which affected several hundred operators was to add skills and responsibilities to the minimum skills of the single-operation worker. As a result, the job now calls for some sharpening of his own tools by the operator, and for the ability completely to set up his machine for each new order from blueprints. A knowledge of how deviations from tolerances will affect the part in subsequent machine operations is required. The ability to make a complete check and inspection of the finished part is called for. This includes a knowledge of how to use a test plate, height gauge, comparator, and other checking tools.

Displacement of Personnel. Installation of the plan meant the displacement of scores of setup men and inspector whose jobs and skills had been absorbed by the operators. The problem of the replacement of these specialists was anticipated. Since the company's operations were expanding during the period of the plan's installation, no men lost their jobs with the company or suffered a reduction in pay. In the milling operations, for example, of 35 displaced setup men, 21 became operators without loss in pay; 2 voluntarily left the company; and 12 were promoted to other jobs within the company, all but one with increases in pay.

Not all setup men or inspectors were removed at once from the Manufacturing Department of the plant when the plan was initiated in 1943.

For a time a certain number were retained as instructors and also to handle the work of operators not yet fully trained. The immediate reduction in indirect labor overhead, however, was striking. Here are the changes in the ratio between operators and setup men for two typical operations—milling and drilling:

For milling the ratio between setup men and operators in 1940 was one setup man for every 16 operators; no operator did any setup work. At the peak of war orders in 1943, the ratio was even higher: 1 setup man for every 14 operators. Between December 1943 and July 1946 some enlargement of the operators' duties had been gradually effected, although the program was not yet completed. By July 1946 the ratio had become 1 setup man for every 52 operators. All operators in the department by that time were making some of their own setups; some operators were making all. By 1950 the setup men had been completely eliminated from the department.

The ratios for drilling operations were:

1940 (before the war)	1 setup man to 22 operators
1943 (war's peak)	1 setup man to 11 operators
July 1946	1 setup man to 48 operators
January 1950	no setup men

At the same time reductions were made in the inspection force, formerly considered necessary for quality control in these departments. By January 1950 all operators were doing the lion's share of their own inspection. To quote the plant superintendent: "Inspection has now been eliminated to the point where the amount is determined by the requests made by the operators for an *inspection double-check* on complicated jobs where they need assistance."

Benefits

The plan of course entailed certain outlays: wages of operators were raised to compensate for the exercise of their new skills, and additional inspection equipment was purchased. But these outlays have been more than offset by lower costs and other benefits.

1. A product of better quality has resulted. As already indicated, in the six years following the initiation of the program company records show a substantial reduction in the losses from defects and scrap. This has been due to several factors but is substantially attributable by management to the "greater responsibility taken by the individual operator for the quality of his work."

2. Less idle time, both for machines and operators, has resulted. It has been found that the operators can set up and check with greater economy in time if they perform these duties themselves, rather than calling over

setup men and inspectors to do the job for them. The cost of setting up and inspecting has been reduced 95%.

3. Job enlargement, management insists, has "enriched the job for the worker." It introduced interest, variety, and responsibility which were not present before. With them it introduced another element indispensable to a healthy work relationship: the importance of the thing produced to the worker. (No matter how important to the company and the customer, the fractional parts of the product are likely to be of little interest to the "primary producer" in the average mass-production department.) In addition to these benefits, the worker began to receive more money for his work.

To summarize, the most obvious results of the job enlargement experiment in this company may be said to be threefold, as expressed from the standpoint of the company, the worker, and the consumer: The *company* considered the chief benefits to be a better satisfied working force, somewhat lower costs of production, and a higher quality of product. The *worker* received from the plan an increase in personal satisfaction on the job, plus higher wages. The *consumer* got the benefit of the improvement in quality of product.

Impact on Plant Social Structure. This is obviously an oversimplified summary which, for one thing, hardly suggests the impact of job enlargement on the social structure of the factory itself. This impact is perhaps quite as important as the fact that the operator's individual job was made more interesting. The factory's status system, for example, was altered in every department where the program was installed through the dropping out of one level between foreman and worker, namely, that of the setup men and inspectors. These functionaries had been exercising a semi-supervisory role, comparable to that of a straw boss. With their elimination, the worker gained in prestige and moved upward in status.

Certain patterns of interactions and communication within the factory were likewise drastically changed. The foremen, for example, now began to talk over their problems, technological or personal, directly and more often with the workers. The factory organization became simpler, more informal, better integrated.

Management was well aware of these effects, in fact had anticipated most of them. One executive commented as follows:

> The program has meant a tightening and simplifying of internal shop organization. Job enlargement of the operator's job reduces the load of supervision over him. He now has one boss, his foreman, instead of what amounted to three. This improves the foreman's relations with his men. Instead of often dealing through intermediaries—the setup men and inspectors—he deals directly with every worker in his department. Multiplying "bosses," whether staff men or experts, or specialists, or straw

> bosses, tends to depersonalize work in a factory. Reducing their number reduces irritation and increases the chances for personal satisfaction *on the job.*

Applicability to Other Companies

The principle of job enlargement is only one answer to the problem of the repetitive job, but the I.B.M. experience does suggest that it may be an important one. The question is: How far is job enlargement applicable in modern industry? A comparison of shop conditions and other factors in I.B.M. with manufacturing operations and relevant company policies in other concerns suggests two conclusions:

1. Over the next few years the principle is susceptible of a limited but important application. Perhaps the jobs of a half million American workers might be affected.

2. The program should not be installed unless a number of factors are favorable. Most of these can be isolated and studied with a fair degree of accuracy.

Shop practices and company policies were unusually favorable in I.B.M. for the introduction of the program. In fact it is fair to say that conditions were "ripe" for this or some similar program. On the other hand, similar and in some respects *more* favorable circumstances do exist in many other companies.

I.B.M. manufactures a specialized and intricate product where the demand for "quality," especially in machining and assembly work, is unusually high. In recognition of this, the company not only is highly selective in its choice of personnel but after employment exposes them to every possible opportunity for self-education. It encourages employees to aim at a better job; and it provides, at its own expense, night schools for self-improvement. These policies unquestionably eased the installation of the job enlargement program and supplied a favorable "atmosphere" for its continued success. Attendance records at the free I.B.M. schools swelled markedly with the introduction of job enlargement.

An expanding market for its product automatically solved the problem of the displaced personnel. As the record shows, the setup men and inspectors whose skills were swallowed up by the operators were readily absorbed into other jobs without loss of pay or prestige. Were job enlargement introduced by a company at a time of declining demand either for goods or for labor, the program would be resisted by both workers and specialists.

Without a doubt the policies most favorable to the introduction of the experiment were those attendant on foremen's relations. At I.B.M. all foremen are called "managers," and as far as practicable they are invested with appropriate duties and authority. The manager-foreman of a section or department in a plant not only deals directly with his men in all technical matters of production but is also the prime authority in hiring, promotion, or discharge of workers under his supervision.

The company does everything possible to make this simplified organizational structure workable. All managers and indeed most executives go to school—on company time—every year, in sessions where technical matters as well as company policies and plans are discussed. It is a cardinal principle of shop organization in the company that the foreman represents management in *all* matters of company policy to the men he supervises. It is easy to see how all these policies were favorable to the introduction of job enlargement. Foremen were able to explain the full scope and significance of the program to operators, setup men, and inspectors, as well as to act as competent instructors in the technical details of the program.

On the purely production side, as against company policy side, the applicability of job enlargement in any plant is obviously dependent on the nature of the manufacturing process. It is clearly not applicable—in precisely this form at least—to an assembly-line operation where a moving conveyor arbitrarily limits the character of the work. It is applicable, however, to a very wide variety of machine operations where setups, tool sharpening, and inspection are called for.

As suggested earlier, there are many plants where job enlargement is "unconsciously" taking place simply because it seems to "work better" in certain departments, although few managers are aware of the broader implications of what they are doing or permitting to take place.

There are companies, however, which are fully alive to both the economic and the psychological penalties of overrepetitive work. For example, James C. Worthy of Sears Roebuck has recently commented:

> We have found that where jobs are broken down too finely we are more likely to have both low output and low morale. Conversely, the most sustained efforts are exerted by those groups of employees who perform the more complete sets of tasks (e.g., salesmen, supervisors, master machinists, etc.) and these likewise exhibit the highest levels of morale and esprit de corps.[1]

In a broad sense, the problem of the repetitive worker is a special case within the larger problem area of overspecialization which exhibits itself in so many sectors and at many levels of modern society. In industry the trend toward specialization of function has clearly tended to narrow in content, responsibility, and personal satisfaction a very large number of factory jobs. But to compensate for this shrinkage, there would appear to be another trend of "expansion." Top management increasingly is obliged to assume broader and broader functions and responsibilities, portfolios, and powers. Alexander Lindsay, the British philosopher, has remarked: "Industrialism has introduced a new division into society, the division between those who manage and take responsibility and those who are managed and have responsibility taken from them. This is a division," he adds, "more important than the division between rich and poor."

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[1] From a paper given by James C. Worthy at the Forty-Fifth Annual Meeting of the American Sociological Society, New York City, December 29, 1949.

The significant question would appear to be: Is such a division, which is one of the diseases of overspecialization, an inherent or a passing phase of industrialism? A society based upon *enterprise* should be able to give its own answer to such a question. In any case, within the important sector of American manufacturing a recognition of the law of diminishing returns in overspecialized factory labor is one way to obliterate the division.

ii. White Collar Workers in an Insurance Company

From R. H. Guest, "Job Enlargement: A Revolution in Job Design," *Personnel Administration*, vol. 20, pp. 13–15, March–April, 1957.

This is a summary of experience with job enlargement in the Colonial Insurance Company of East Orange, New Jersey. In three areas of its operations the company reversed the time-honored principle of breaking jobs down into their simplest logical elements and assigning jobs to a fraction of the whole. And, like so many other cases we have noted, the shift to enlarging the jobs came not because somebody pulled the idea of job enlargement out of thin air. It came about almost as a matter of necessity.

In the Underwriting Department back in '52 the head of Methods was being called repeatedly into the department because of a high error ratio, high turnover and generally poor morale. Over a twenty-month period in one group of four jobs, 32 people had been hired and quit.

Although the operation involved large volumes of work, it was not complicated, so it was thought best to assign girls to individual jobs, each working on a fraction of the underwriting clerical procedure of application setting up, application control and application suspense. Still, no perceptible change.

Perhaps something was wrong with supervision, it was thought; but nothing showed up here after careful examination. With the high turnover, they thought that their placement policy was not right. Consideration was given to choosing girls for this work on the basis of psychological aptitude, etc. They tried married women, thinking this might do the trick, but it did not.

Finally, the head of methods, A. J. Hastaba, decided to try a bold experiment. Each of four girls was given the title of application control clerk. Each was made responsible for the entire policy application control procedures while the case was in the Home Office from the point of incoming mail reception to final mailing with the exception of one process involving okaying the application by the professional underwriter. Each girl was also made responsible for a group of applications broken down in alpabetical sequence of names, rather than by numbers. If the applicant's name was Smith, everyone knew precisely who was responsible for the S's.

I talked at some length with the supervisor in charge. Her enthusiasm was obvious. She admitted that at first the idea sounded impractical.

> "I wasn't too happy about the change, although we all knew something had to be done. With a turnover of 12 girls for 4 jobs, the supervisor was spending at least half a day just training people. A girl would be here a couple of weeks and leave; then we would have to begin all over.
>
> "When the change was made, the girls at first thought they couldn't do half of the work. Gradually it built up. It took six months to perfect the system. After a while not only did they find they could handle the work load but there was even some idle time, so filing was added. They also actually came to do some of the routine correspondence work and made contacts with the agents to check on application details. In three years I have had only one girl leave. She got married. I have kept track of the accuracy picture. We used to have as high as 50 to 60 per cent errors. And working the way we did, you could never pin the errors down. Now with one girl handling all phases of the application, we know precisely who is responsible.
>
> "As a matter of fact, our error rate is less than one per cent. And as supervisor, I am much freer to carry out planning functions, make outside contacts, run statistical surveys. I have also been able to make up a complete procedure manual in detail. When a girl is absent, I have complete flexibility because any one of the others can step in on the job. We don't have any bottleneck trying to break someone in on a single operation. Each girl knows all of the operations."

So much for the supervisor. I talked with one of the girls who had had some experience under the old system. She complained of the former routine and boredom. She admitted that the first few weeks under the new system were hectic. She not only adjusted to but expressed genuine enthusiasm for the job. She ended the interview by saying: "I wouldn't go back to the old system for anything."

More recently the job enlargement principle has been expanded to one of the sections of the Debit Policy Department. Using the same alphabetical principle for processing applications, each of five girls now has the following formerly separate operations all under her jurisdiction:

Sorting and distributing incoming mail.
Matching and attaching various papers.
Ordering name file search.

Setting up application files.
Maintaining suspense files and follow-up.
Numbering and photocopying.
Calculating premiums.
Coding for punch card accounting.
Checking and binding, then mailing the policy.

The manager of the section reports that despite a raising of some job class groups from 4 to 5 to pay for increased responsibility, the unit costs have not increased. In other sections that have been reorganized there has been a reduction in unit costs with an increase in volume at no increase in personnel. Turnover is obviously lower, he reported. The manager also underscored the advantages I mentioned earlier:

Better coverage during periods of sickness and vacation
Fewer bottlenecks (i.e., work doesn't all pile up on the desk of an absent clerk)
Pin-pointing of errors
Greater flexibility
Increased understanding of over-all operations
Less monotony

iii. White Collar Workers and Supervisors in a Public Utilities Company

> From J. D. Elliott, "Increasing Office Productivity through Job Enlargement," *The Human Side of the Office Manager's Job*, American Management Association, Office Management Series, no. 134, New York, 1953, pp. 5–15.

During this era of mechanization and mass-production methods, we have become imbued with the thinking that a high degree of specialization brings about economy of operation. As a result, we have persistently specialized many jobs without looking thoroughly into the cost of specialization, failing to realize that a less specialized operation may well be more economical or that duplication of operations is perhaps being created.

When I think of job enlargement in the office, three objectives come to mind. All three are closely related. All three, if accomplished, can normally be expected to increase production and reduce cost. These three objectives are: (1) to reduce job monotony, (2) to utilize employees' intellectual capabilities to a greater extent, and (3) to decrease the amount of specialization where it has created duplication and increased costs.

We have more than 1,000,000 customers in our [Detroit] Edison territory and bill more than 30,000 accounts per day in [the Customers Billing] department. In addition to billing accounts, over 2,000 customers' service orders are processed each day. . . .

Enlarging the Worker's Job

We have three machine work groups [for printing bills]. The work flows from machine to machine within and between these groups in a traditional production-line fashion. As a result, we had many specialized machine jobs within each of the work groups. Such a high degree of specialization began to take its toll in low employee morale and in lack of flexibility of operations. So we established one machine-job classification in each work group, requiring each operator to be able to perform any job in the group. These operators are now assigned by their supervisor to any task necessary to produce an even flow of work when disrupted by absences, machine breakdown, and the like. In fact formal "assignment" to tasks by the supervisor is not always necessary, as the employees know themselves where they are needed the most. Such free movement of empoyees promotes teamwork not formerly prevalent. When work is running smoothly, the operators rotate between machines according to their own collective choosing.

In one of the machine groups, among other things, we prepare statements for customers whose bills are past due. While these statements are run on a tabulating machine, it is necessary to type a good portion of them. We have needed three typists to keep up with the machine. The typists were typing practically all day long, and one of the rotating machine operators was operating the machine at all times. The typists were also supposed to help the operator to run the machine, but there was a tendency not to do so, particularly because there was a full-time operator assigned to the machine. The supervisor in charge of the group thought it would be better, job enlargement-wise, to replace one of his machine operators with a typist. It would then be the full responsibility of the four typists to work as a unit and to run their own printing machine. No longer would the machine operators include this printing machine among the machines they were to operate. It was felt that we were not taking anything away from the machine operators because they still had a large variety of machines to operate and it would mean that each typist would be spending about 25 per cent of her time on the printing machine. This gave the typists more variety and a better understanding of their operation, and it gave the supervisor much more flexibility. Previously there was a certain portion of lost time on the part of the machine operator and the three typists who were waiting for each other's work. This time is no longer wasted.

Enlarging the Supervisor's Job

I have given a few examples of job enlargement as it pertains to the office worker's job. . . . Job enlargement at the supervisory level can bring equally good or even better results. Some of the job-enlargement improvements made in the Customers Billing Department at the worker level are the direct result of job enlargement at the supervisory level.

Duing the past few years we have been enlarging the job of first-line supervisors, at first, just because it seemed to be the thing to do and, more recently, because we have acquired the job-enlargement philosophy. The job of our first-line supervisors was specialized to the extent that it was primarily their duty to enforce rules and regulations and to help expedite the work within their group. Our supervisors had some responsibility with very little authority. While their job was not necessarily monotonous, the supervisors had the minimum opportunity to think for themselves or to venture beyond their own immediate work group.

It was the duty of the so-called "front office," consisting of staff men in addition to the department head and his assistant, constantly to study routines and procedures and to write directives as to how the work was to be done. All the supervisors had to do was to follow instructions, although they may have been consulted on procedure changes occasionally. The front office was fully responsible for such functions as preparing the budget and keeping all cost statistics, hiring and firing employees, making wage adjustments, handling employee grievances, and shifting employees between groups to expedite the work during peak periods and absences. In addition, the department head or his assistant had to be consulted by the supervisor in handling personnel matters such as granting time off and scheduling vacations.

Today, all these responsibilities and more have been delegated to the first-line supervisors. They also have been given authorities commensurate with their responsibilities. When we now say these supervisors are part of management, we mean just that.

Enlarging the Work Group

I have given examples of job enlargement at the worker level and at the supervisory level. I should like now to describe a job-enlargement undertaking involving two entire work groups.

We had one work group which maintained the tabulating cards in which were punched the names and addresses of all our customers. This was a voluminous file containing over 1,700,000 tabulating cards. It was the duty of the people in this group to assign account numbers to new customers by making reference to the file, as well as the many other tasks normally performed in relation to maintaining such a file. We had another group which set up the name and address cards and other billing records from service orders received from customers. This group consisted primarily of a battery of key-punch operators and a battery of checkers. This group and the file group worked closely together.

We decided to assign the activities of these specialized groups to two new identical work groups, each of which would be responsible for all the functions performed by both the old groups. In other words, one group would be responsible for the key-punching, checking and maintenance of the name and address cards for about one-half of our customers, and the other group would have the same responsibilities for the other half. The old groups were nearly the same size, having about 17 employees each. All the employees were divided evenly between the two new groups except for two employees who were assigned to a third group.

Before the change was made, one group in particular was consistently behind schedule. The people in this group were being pushed all the time and were working overtime a great deal. There seemed to be a greater number of discrepancies than there should have been. We had reached the point where it was quite obvious that additional help was needed. However, it was decided to defer the hiring of additional help until the new groups were established, so that we might determine how the help should be distributed. We anticipated some confusion at the time of rearrangement because half the people would be working for a new supervisor and because a physical rearrangement of desks and files would be necessary. The expected confusion was practically non-existent.

Immediately after the change, the two supervisors discovered that much duplication had existed in the two former groups. They had been making certain checks on each other's work and performing many other operations made necessary by the constant flow of work between the two groups. This was no longer necessary because each group was fully responsible for the operations within its sphere of activities. With the discontinuance of these fringe jobs, the work groups were practically on schedule within a week after the change was made.

With the establishing of these two new identical groups, the supervisors' jobs were enlarged automatically. Each supervisor now, while having about half the number of accounts to work with, has had his responsibilities broadened to cover a wider range of activities. The same thing is true of their assistants. Once the new groups were well established, we began to tackle the enlargement of other jobs within the groups. Each new group had nine clerical job classifications. We could see some problems in enlarging the jobs of two of these classifications; so we deferred action on these and tackled the remaining seven. After study and review with the employees themselves, we came up with three job classifications to replace the seven. These new jobs were duly established through our normal company procedure of job evaluation and have been installed, each of the new jobs containing the duties of two or more of the former jobs.

Even the employees in the two job classifications which were not changed have a better understanding of their work because they can see the over-all picture of operations better and because, during peak periods and absences, they assist on a wider variety of work. I am sure they, too, now find their jobs more interesting.

Job Enlargement Reduced Costs and Increased Productivity

In general, our experience with job enlargement has been as follows: There is an upward movement of job value which results in some higher pay rates to compensate employees for their broadened duties. Over-all costs are reduced and productivity increased owing to such factors as increased job interest on the part of the employee, greater flexibility of workers, elimination of needless operations, less wasted time, and reduced workforce. Employees are capable of assuming broader responsibilities and like it. All this, of course, is in addition to relieving job monotony.

We have considered job enlargement in some other areas of activity and have later abandoned the idea because we were not fulfilling our objectives. However, no backtracking has been necessary on any change once undertaken. A few employees like repetitive work or are not capable of growing with their jobs. No attempt was made to enlarge jobs where this was the case.

Indications of the Need for Job Enlargement

I certainly don't mean to imply that punched-card equipment or, for that matter, specialized manual operations should be done away with any more than the assembly line in the factory should be eliminated. Nor do I want to imply that I am against mechanization, because usually machines reduce costs and often they take over repetitive jobs—but then they sometimes create them, too. What I do mean is that a second look is necessary to determine what job enlargement can do for companies cost-wise if for no other reason. Maybe, after the job-enlargement philosophy is acquired, new costs studies will point out the area where overspecialization has proved costly. Our electric industry is constantly studying various phases of its customer bookkeeping systems and billing equipment to improve customer relations and still reduce costs. I can't help but feel that job enlargement will play a more important role in future studies.

We don't have to look to industry-wide studies for indications of the need for job-enlargement thinking. In my own company a comparison of absences was made in 78 work groups throughout the eight accounting departments reporting to my boss, the secretary and general accountant. These work groups were divided into three classifications: groups whose work is highly repetitive, moderately repetitive, and non-repetitive. The absence rate of employees in the groups whose work was classified as highly repetitive was 20 per cent higher than in the other two groupings, between which there was no significant difference. Now, this may well have "just happened." However, when such studies point in this direction, it makes us wonder, doesn't it?

Conclusion

I think of this whole area of specialization versus non-specialization as a pendulum which, at the turn of the century, stood near the one extreme of non-specialization Today, with all our specialized procedures, it stands near the other extreme. I think of the ideal position of the pendulum as being somewhat short of the latter extreme. I think of the job-enlargement philosophy as the means of finding the notch along the periphery of the swing into which the pendulum should fall to gain the ultimate in production. No expert can tell us where this notch is. We have to think job enlargement-wise and analyze each job ourselves, because the notch is at a different place for each.

iv. A Controlled Experiment in Job Enlargement

From R. H. Guest, "Job Enlargement: A Revolution in Job Design," *Personnel Administration,* vol. 20, pp. 12–13, March–April, 1957.

The first piece of experimentally controlled research [in job enlargement] was carried out on the West Coast a few years ago by an industrial engineer.[1] With the cooperation of the company, he chose a manufacturing department making a line of similar products. At the start of the experiment, the activities of the department were organized according to the latest manufacturing practices. The product was made on an assembly line, using carefully specified minutely subdivided operations performed by twenty-nine girls with one to seven years seniority. The work content involved performing one of nine simple operations.

Keeping another similar group as a control, the jobs were changed first by eliminating the assembly line method and having all nine operations done by each of the girls. They were also made responsible for their own inspection (previously done by inspectors), and for getting some of their own supplies. After six days the productivity of this group exceeded that of the old type of operation.

The most notable change came in the number of rejected assemblies which dropped to one fourth the original number. Under the new set-up, remember, the girls did their own inspection. Thus, according to Dr.

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[1] A. R. N. Marks, "An Investigation of Modifications of Job Design in an Industrial Situation and Their Effects on Some Measures of Economic Productivity," unpublished doctoral dissertation, University of California, Berkeley, 1954.

Marks, who made the study, there was improvement in both quality and productivity.

Further observation revealed that under the new system management was able to operate with much more flexibility since all of the girls knew all of the jobs. When quality errors were made it became much easier to identify who made the error. Before, the error could have been made by one of several people. The new system reduced the service function of material handling and of inspection. The operators themselves liked the new system much better. They expressed a feeling of accomplishment at being able to make the entire product. There was less need for direct supervision.

5. NOTE BY THE AUTHOR

To seriously attack problems of machine-man relationships, the author suggests as future research [1]

> . . . a comparative literature of job content, industry by industry, to fit into a broader comparative literature of work environments. Already we have descriptive job categories in most industries such as learning time, hazard, physical effort, mental requirements, and so on (on which job classes and wage rates are today being calculated). What we are recommending is a broader and deeper study which is oriented toward the human personality, and which takes account of such factors as psychological satisfactions, . . . opportunities for growth, and opportunities for the acquisition of different and more balanced types of mental and physical skills. Besides this we need to know more about the psychological effects of control over powerful machines. And certainly the factor of traction should be fully analyzed and compared in various jobs and work environments. Also, we need to know more about attitudes toward the product.
>
> In addition to this list, which is far from exhaustive, there are two very large areas that call for further and more vigorous research. The first is the question of continuity versus interruption. . . . And the second is the question of the effect of different types of job experience on character and personality over time.[2]

Granted the probability that there will always be many jobs whose content will be unrewarding to the doer, the advantage of an inventory of job content as suggested is that society would then know how to act, or whether under existing circumstances it could act at all. As an example, here are five major classifications which could be made:

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[1] Charles R. Walker, *Toward the Automatic Factory,* Yale University Press, New Haven, Conn., 1957, p. 209.

[2] Significantly new comparative research which explores worker satisfactions and dissatisfactions on an industry-by-industry basis is in progress (as this book goes to press) under the auspices of the Fund for the Republic (Ford Foundation) and the University of California. Some preliminary findings by Robert Blauner have been published in Walter Galenson and S. M. Lipset (eds.), *Labor and Trade-Unionism, An Interdisciplinary Reader,* John Wiley & Sons, Inc., New York, 1960.

1. Jobs whose content already calls for skill, experience, and judgment (no action needed)
2. Jobs capable of enlargement, or in other ways of being made meaningful and significant to the doer (action as suggested in this chapter)
3. Jobs about to be mechanized or eliminated (temporary compensations provided)
4. Jobs which are highly repetitive and paced and with a very short time-cycle, but which pay well and are not greatly disliked because the incumbents can talk with each other or daydream (action not pressing)
5. Jobs whose content is extremely arduous and inherently dangerous but which have professional standing and pay well (further study to reduce fatigue and hazards)

This is merely a tentative list. It is suggested that the reader make his own classification as he reads the following selections, or out of his own experience.

D. MEN, MACHINES, AND ORGANIZATIONS: A REAPPRAISAL

The author did research for a number of years in a very large American corporation whose operations were based on accepted principles of mass production. Out of thousands of conversations with members of management, two remain very vividly in his mind and may serve as an introduction to this section.

The chief industrial engineer of the corporation described one day a program which, when completed, would tell every worker in the corporation "exactly how to do his job down to the last detail." This would serve a psychological as well as mechanical purpose, he added. "Not only will the operators not have to think any more, but they will be much happier on the job and more loyal to the company when we are able to show them that we know so much more about the job than they do."

Here, in the program described by the chief engineer, technology and what he thought about it was clearly having a direct effect on the organization of work in his company. But more than that, the principles of mass production—especially high standardization of parts and tasks—had been transformed into a psychological theory of what makes men happy at work. Peter Drucker sums up the problem suggested by this conversation as follows: "The industrial engineer sees in the human being a tool and that means that, to him, the human being is the more productive, the more thoroughly his work has been set up and laid out *for* him. The social scientist lays stress on man's need to participate. He, therefore, concludes that the human being is the more productive and the more efficient, the more he *himself* designs and lays out his own work."

The questions and problems here suggested are more complex than indicated either by the engineer or by Drucker's comment, but the example may serve to stress the role played by technological and sometimes by engineering assumptions in the organization of mass-production factories.

The other conversation was with the chief operating executive of the same company. It concerned the relation of the central office to the individual plant. "In some respects we have a centralized, almost a military type of organization because of the technology. The different works managers and their staffs *must* follow exactly the drawings and directions we give them for manufacturing a new product. Those things are decided on here. All plant managers must follow through what we tell them to the last detail. We tried giving them local option on how to do the job. It didn't work. We are a highly technical mass-production industry. I don't approve of this policy from a human and psychological point of view. Every man should have some freedom in how to do his work. But technical and engineering considerations dictate our policy."

Here again is the belief that technology requires a certain type of organization, and indeed a certain type of "command" relationship between the administrative main office and the individual plant. One striking difference, however, between the viewpoint of the chief engineer and his superior, the chief operating executive of the company, stands out. The engineer derives a psychological theory out of engineering practice. The operating executive is careful to keep his psychological theory separate from his acceptance of what he believes to be industrial reality. Both make it very clear that there is an important relationship between technology and organization.

The examples suggest a number of basic questions on which we shall try to throw light in this section.

Assuming there is some free choice in the way management organizes itself, as all theorists and most managers believe, are there ways—even with an extreme mass-production technology—of bringing greater flexibility and local autonomy into corporate organization?

Or this related question: If certain technologies appear to encourage authoritarian types of leadership, are there other technologies which encourage more "democratic" types of organization, and what is sometimes called a more "consultative" type of leadership?

What other forces are there besides technology which influence styles of leadership, as well as types of organization?

Since we live in a period of greatly accelerated mechanization in all industry, culminating in some companies in partial or complete automation, are old forms of organization—and with them older forms of leadership—becoming obsolete?

If so, what are the new organizational forms which fit an age of very rapid mechanization and automation and what are their effects on people and on human and cultural values in our time?

These are a few of the broad questions on technology and organization which the selections in this section are designed to put into concrete terms and to clarify. This section will discuss and illustrate the author's assumption that a rapid chain reaction may be observed in all modern societies between three phenomena: technical innovation, organization, and human behavior. The phrase chain reaction has been chosen to emphasize speed—speed in the output of technical innovations, which are now tumbling over each other, speed in the adaptation of organizations to new technologies, and speed of human reactions to the changed organizations. The rate of change and of human adaptation—or resistance to change—vary from industry to industry and from country to country. But in the main, the rapidity of the chain reaction—in comparison with past times—has forced the fact to the attention of everybody. What we are attempting to do in this section, however, is not simply to recognize the fact, but to understand it through a study of typical examples. We shall also note what others think of these interconnected phenomena (in the chain reaction) as they pose practical problems to both leaders and followers in many types of organization.

Begin by looking briefly at two classical forms of industrial organization, the vertical or line organization and the horizontal or line and staff type. For many years most people thought of relationship in industry as chiefly line relationships; that is, they thought of people as related to one another in vertical or hierarchical terms. There was a works manager, for example, for the factory; under him a superintendent, under him one or more department heads, under each a number of general foremen, under each general foreman a quota of job foremen, and finally, at the bottom of the organizational pyramid, the workers. What was frequently called the line-of-command type of relationship (a term borrowed from the military) appeared to be the normal one (regardless of differing technologies) in most industrial organizations. Slowly at first after the turn of the century, and then with a rush, the technical complexity of manufacturing demanded a host of new specialists or *staff functionaries*—engineers of many varieties, research and development technicians, time and standards people, personnel and labor relations managers, quality control and cost control experts, and so forth. Industrial organizations became infinitely complex, but most organizations were considered variants of the line *and* staff (combined vertical and horizontal) type of organization.

Both of these classical types of organization are illustrated in somewhat simplified form by the first selection, "Technical Change and Social Structure." A special merit of this selection is that it shows very clearly the force of technical innovation in transforming company and plant organizations and changing them from type one to type two. Further, it suggests the relation of the organizational changes to human behavior and human problems.

Is there a third and perhaps also a fourth and a fifth type of industrial organization to be reported on, which follow in sequence and correspond to still newer technological innovations? Yes and no. Organizational concepts and structures are now changing so rapidly that it is too soon to put numbers and labels on them. We are including, however, three or four selections to describe this state of flux and adding further references for the interested reader.

Perhaps the best selection for illustrating this state of flux in organizational forms is "Logic of Automation" by Melvin L. Hurni, which reviews some of the dynamic advantages but also the less well-recognized factors of limitation which automation introduces into managerial organizations. It does not spell out the precise effect of technology on company structure in the direct and literal fashion of the steel mill case history, but it emphasizes the upsetting and transforming impact of automation on investment, marketing, financial policy, product design, and planning. Out of radical transformations in these areas—all stemming from *technical* innovations—are emerging novel concepts and novel forms of industrial organization. "Technology in a Modern Science-based Company" is from a talk by the chairman of the board of the largest electrical company in the world. This is not a systematic discussion, but it suggests the many-sided effects of modern technology on management thinking and planning.

Experience with automation is still too new to have produced anything like an adequate documentation of organizational changes introduced to fit the technical ones or of their effect on human relations and human behavior. A convincing sample of what *some* of the human effects may be is given in a case study of a newly automated power plant. This study appears under the title "Impact of Automation on Organization and the Individual."

Having touched mainly on the highlights of our subject, we turn now for a closer look at human problems at the factory level, and at some of the results of recent research.

For a long time the human problems connected with organizational and technological structures such as we have discussed went unnoticed. One of the first to explore and analyze them at the lower levels of industrial organization was F. J. Roethlisberger. "Each industrial concern has a social as well as a physical structure," he wrote. "The failure on the part of management to understand explicitly its social structure means that it often mistakes logical coordination for social integration. . . . This confusion interferes with successful communication up and down the line as well as between different groups within the industry." Roethlisberger, who was trained as an engineer before he became a social scientist and a professor at Harvard, has always recognized the threefold chain reaction between technology, organization, and human behavior. (Selections from his writings, under the title "Engineering Logic vs. Social Realities," are included in this section.) Consider, for example, what has happened to the average foreman as a result of the technical complexity of the modern factory. Roethlisberger, in a famous essay,[1] analyzes the dilemma of the supervisor surrounded by a dozen bosses, each a technical staff man who has taken away a different segment of what used to be the foreman's job. The process engineer takes away the planning of the job, the time standards department the setting up of the job, the personnel department the hiring and firing of the employees, etc. As the reader will see in certain selections in this section, the last word has by no means been said on the right role for first-line management, the foreman, in this age of technology. His job is still changing and still calling for reappraisal.

Since the early writings of Roethlisberger and others at the Harvard Business School, a host of other researchers have begun to fill out the picture of man working and man managing—or being managed—in the modern factory under the influence of technology. We can only touch on the highlights of that picture.

One of the first studies made by the Technology Project at Yale University was called "Human Relations in an Expanding Company." It was made in a highly technical "science-based" company, the International Business Machines Corporation, and was designed to find out *why* human relations had apparently improved as the technical process grew more complex and while the company was doubling in size. Out of that study, one of the authors, Richardson, who was originally trained as a geographer, developed the idea that a lot could be explained in the modern factory if you looked at people as related to work flow. "Look at them horizontally," he said, "from machine to machine, rather than vertically."

"A work flow system in any factory may be compared to a river stream," he wrote. "The raw materials, the orders, the engineering blueprints, all start, so to speak, at the headwaters of the work stream. Unfinished parts flow downstream from operator to operator, section to section, division to division, until they are assembled, packed and shipped at the stream's end."[2] Among the results of this approach was the discovery that good or bad human relations *between* operators or supervisors along the work flow were sometimes more important in determining output, quality of product, and human satisfaction in the factory than the character of the *up and down line* relationships. Some years later, Frank J. Jasinski added another dimension, "diagonal relationships," as between a foreman and workers in another department. Diagonal relations are frequent and important on assembly lines. "Management rarely recognizes and provides for horizontal and diagonal relationships," he wrote. "While much attention has been given to the conflict between line and staff, almost none has been paid to similar difficulties within the so-called 'line' organization. Yet . . . both horizontal and diagonal relationships are called for by the technology itself." [3]

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[1] F. J. Roethlisberger, "The Foreman, Master and Victim of Doubletalk," *Harvard Business Review*, vol. 23, no. 3, pp. 283–298, April, 1945.

[2] Richardson and Walker, "Human Relations in an Expanding Company," Technology Project, Yale University, 1948, p. 2.

While the impact of technology on organizational relationships was being studied at the work level, many industrial psychologists and sociologists had been approaching human relations in modern organizations from another point of view, that of the leader-follower relationship. What have come to be known as "styles" of leadership have provoked a considerable volume of research. Which is the most effective kind of leadership, it has been asked, for an executive or administrator or foreman, authoritarian or democratic or some other kind. Kurt Lewin at MIT included such questions in the pioneering studies which he called "action research" (see Bibliography). As suggested at the beginning of this section, strategic to our inquiry is, of course, the question: To what extent is style of leadership influenced or determined by technical factors? Some wholly new ideas—for most Americans—on kinds of effective leadership may be found in the section entitled Technology in Non-Western Countries.

A word is in order, perhaps, on how research is being conducted today to throw light on the questions raised in this section. How can one look at or study objectively human relations in a factory—or in any kind of human organization? The reader, if he has had even a nodding acquaintance with organizational literature, has heard about "formal" and "informal" organizational structures. The organizational chart is, as a rule, the accepted picture of the company's formal organization. But everyone knows, even the makers of organizational charts, that they only *approximate* reality. So the term informal organization [4] is often used—as in our discussion—to label what really happens: who really has the power, and who sees whom in fact and why, etc. An understanding of the informal as well as the formal organization of a company (it is no disgrace to have discrepancies between the two; all human organizations do) will help both men and management in their daily relationships with one another. But how can the informal organization be investigated? How can one objectively study human relationships in a factory or any other kind of organization? For this book, the question is even more specific: *How can one reliably spot the effects and weigh the importance of different technologies on human beings?*

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[3] Frank J. Jasinski, "Foreman Relationships outside the Work Group," *Personnel,* vol. 33, September, 1956.

[4] Some social scientists use the term "informal organization" to refer to cliques within the organization formed without reference to the formal purposes of the organization.

Actually, social scientists and many practical administrators have, in recent years, been discovering new tools and sharpening old ones to do just these things. One of the most important tools, especially for the purpose of looking at technology and human relations, is counting and comparing actual human contacts between people, such as between foreman and workers, or between a vice-president and his several staff officers, or between workers at one point on an assembly line and workers at another point. These contacts are called "interactions," meaning any kind of human contact—a conversation, a hello, a handshake—between two people or several, and the analysis of their significance is often called "interaction theory."

Interaction is a surprising tool. At first blush it seems absurd that anything as mathematical as counting conversations or other interactions between people could possibly help to explain anything about *human* attitudes or behavior. But it does—as will be shown—because the human personality is so dependent for normal balance and development on a reasonable number of contacts with other personalities. For example, the problems already discussed under Revolution in the Machine-Man Relationship illustrate the usefulness of interaction theory. One obvious source of impersonality, and of boredom, is the fact that the technological work environment makes it hard for the workers to talk to each other. Sampling the interaction rate, i.e., the number of times a man speaks, or otherwise interacts with somebody else and is answered, is one convenient way of comparing one job with another, or even one whole industrial occupation with another from the standpoint of an important area of *human* satisfaction. That area, in this connection, is free association with one's fellows and with people who have a common interest in the work they are doing. Obviously of importance, besides the *number* of times people are in contact, is *what* they say and *what* they feel. But under some circumstances the sheer frequency or scarcity of interaction often explains a good deal or points the way to causes of human conflict in a factory which otherwise would have been missed.

Now turn again to the immediate theme of this section, technology and human organization, and consider three contrasting types of manufacturing organization: a job-lot shop, a mass-production assembly line, and a very modern factory that has installed automation. Let us look at human relations in all three. A fairly unrestricted or, to use the psychologists' word, "permissive" type of human relationship characterizes a considerable number of job shops in industry. In other words, men are free to leave their machines occasionally, vary their work pace, and from time to time talk to their fellow workers and supervisors. These permissive characteristics are obviously related to, and sometimes required by, the technology. A more restricted type of human relationship characterizes an automobile assembly line, as we have already seen. The character of both worker and management relationships is determined largely by the technology of the "moving belt." Finally, a *functionally interdependent* type of human relationship characterizes certain automatic and semi-automatic factories. (See "Impact of Automation on Organization and the Individual.")

Of course, if you are looking for human satisfactions or dissatisfactions in any given situation, you will want to know the content and quality of the interactions between people as well as their quantity. This suggests the other tool now very widely used by social scientists in studying life in human organizations—the interview, long or short, structured or unstructured, surface or in depth, to name a few varieties. Floyd Mann and others at the Survey Research Center in Michigan, have found that the questionnaire, when used with skill, is a useful tool both for qualitative and quantatative data in the field of technology and human relations.

What a shame no one had "interviews in depth" with the owners, "overseers," and "hands" in the early textile factories in eighteenth-century England, or in the guild workshops of medieval Europe, or with the sculptors and stonecutters who built the Parthenon! With such "data" we could truly compare work environments over historic time and perhaps obtain a better perspective of our own culture. But to return to the modern world: When the tools, interviews and interaction analysis, are combined, as they have been in several of the studies of technology and human organization selected for this book, a fair understanding of organizational realities can be obtained.

There is also another tool which recently has been chiseled and sharpened into its present form: detailed and systematic on-the-job observation. How a man *actually* spends his time, not how he *thinks* he spends it, is a datum of enormous importance in analyzing human personalities and the organizations in which they work. Excerpts from a study of what fifty-six foremen actually did during every minute of their working day are included in the selections. (See "On the Job Observation: A New Tool for Research.") One of the striking findings of this study was that an assembly-line foreman's work day is made up of 400 to 1,000 separate and discrete incidents, meaning that he turns to do something different on an average of every minute or less during the working day. Psychologically, therefore, he must have a high tolerance to variety and interruption. Contrariwise, the automobile assembly worker who does, on an average, the same thing over again every two minutes during his working day must have a high tolerance to routine. Both of these diverse demands on human personality are imposed by the technology of the moving line.

So much for the tools that are used to explore technology and human organization. Some of the most interesting and productive research in recent years—using all these tools—has been done on work groups of all kinds, crews or teams in different kinds of industries. Here the counting and analysis of contact between individuals (interaction theory) becomes the means not only of explaining the dynamics of work groups, but of defining them in the first place. It is obvious that unless you have people associating with each other face-to-face and interacting over a certain period of time you may have a crowd or an "aggregation of individuals," but you will not have a group, and if you are talking about people at work in industry you will not have a "work group." It is not hard to see how the technology of any given industry conditions or determines the *kind* of work group you will have, or if you will have any group at all. To give some idea of the range of work group organization in modern industry, take most of the metal industries, steel, copper, aluminum, and so forth. Around the furnaces and rolling mills in all of them one finds work groups, or crews, or teams. Close-knit cooperation, teamwork between five or twenty-five men, has long been considered the most efficient way to get the job done. You might say the technology in these industries demands a work group. Now go to the other extreme. In certain chemical plants there have been, for some years, control-board operators who sit alone all day before gauges, charts, and levers; they see one or two other human beings in the course of the typical work day, perhaps the general foreman or an inspector once or twice a day. The industrial sociologist has a word for them: "isolates." In England in certain highly automatic installations, isolates have threatened to strike for "lonely money." Here the technology demands not teamwork, but operators who can tolerate isolation from their fellows.

Between these two extremes on the spectrum of work groups in modern industry is a very great variety of different mixtures. In some work settings, men work at machines, but the layout, the low noise level, and the managerial "climate" are such that they can talk to each other to some extent during the working day. Or perhaps the techniques of the job demand that they go to a tool crib or to a blueprint room. Considerable "interaction" may be permitted or even required by such activities. Both workers and supervisors may therefore perceive themselves as members of a certain kind of work group which is coterminous with the shop or department in which they work. Then there are the men or women on assembly lines of all kinds. Here the work groups are apt to be weak. The technology does not demand that the men act like a team, nor does it give much opportunity for social interaction.

The selection "Work Groups on the Assembly Line" discusses the main social and psychological uses of work groups in industry and underlines such uses by showing what happens on automobile assembly lines where the groups generally tend to be weak. A second selection, "Work Groups in a Semi-automatic Steel Mill," gives one instance of the changing character of groups under partial automation.

Since it has come to be very widely recognized by social scientists and by many administrators (in government, in the armed services, and in industry) that work groups are often important to efficiency and to satisfaction at work, much study—and even some experimentation—has been given to their dynamics. With ever more rapid mechanization of industry in general, with the constant growth of science-based industries like electronics and atomic installation, and finally with the advent of automation, certain questions regarding the work group are being asked more and more insistently:

Does an advanced mass-production technology virtually destroy the work group and the kind of on-the-job human relations and socialization associated with the smaller machine shop type of work organization?

If so, is there any way of restoring work groups, or at least some sense of shop community in the advanced mass production sections of our economy? [5]

Will automation, by its demand for isolated control-board operators and by its substitution of automatic machinery for men, destroy the work group entirely? Or will it create new kinds of work groups and work associations in industry?

In the new technological settings of the most modern factories, what has been happening to the traditional relationships between operator and supervisor, between both and maintenance, and between them all and the factory manager?

Some of the selections at the end of this section either offer limited answers to some of these questions or point in the direction where those answers may be found.

The next selection, by James Worthy, takes the earlier theme of repetitive and overspecialized jobs for workers and supervisors which was first discussed in Section C, Revolution in the Machine-Man Relationship, and puts it into the perspective of the total organization.

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[5] Incidentally, there are some managements who fear strong, well-knit work groups among their employees. They fear they may become the nucleus for anti-management activities. The more thoughtful managers, however, neither reject nor encourage work groups out of hand, but ask this question: What are the conditions which make for a productivity-minded work group, and what are the conditions which make for an anti-management work group?

Looked at *organizationally,* the trend toward narrow specialization for the worker becomes overfunctionalization for the executive. This, according to Worthy, leads to a deterioration in the quality of industrial leadership. "In the more elaborate and complex organizations, the individual supervisor or executive is subject to constant control and direction and has little opportunity to develop the qualities of initiative and self-reliance." Decentralization and less specialization are recommended. The article from which this selection is taken appeared in 1950 and was based on research "in several hundred different company units."

Many of the ideas expressed appear as valid today as when the paper was written, but technology—and with it organizational theory and practice—has not stood still.[6] The multiplication of high-speed computers and mathematical techniques for decision making has led, for example, to speculations that the theories and practice of decentralization and despecialization in jobs and functions would be reversed. One of the most provocative and uncompromising predictions of this reversal is contained in "Management in the 1980's" by Leavitt and Whisler.[7]

> Broadly, our prognostications are along the following lines:
> (1) Information technology should move the boundary between planning and performance upward. Just as planning was taken from the hourly worker and given to the industrial engineer, we now expect it to be taken from a number of middle managers and given to as yet largely nonexistent specialists: "operations researchers," perhaps, or "organizational analysts." Jobs at today's middle-management level will become highly structured. Much more of the work will be programed, i.e., covered by sets of operating rules governing the day-to-day decisions that are made.
> (2) Correlatively, we predict that large industrial organizations will recentralize, that top managers will take on an even larger proportion of the innovating, planning, and other "creative" functions than they have now.
> (3) A radical reorganization of middle-management levels should occur, with *certain classes* of middle-management jobs moving downward in status and compensation (because they will require less autonomy and skill), while other classes move upward into the top-management group.
> (4) We suggest, too, that the line separating the top from the middle of the organization will be drawn more clearly and impenetrably than ever, much like the line drawn in the last few decades between hourly workers and first-line supervisors.

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[6] A brief but excellent review of leading theories of organization and leadership from 1910 to 1960 may be found in Warren G. Bennis, "Looking Around," *Harvard Business Review*, January–February, 1961.

[7] Leavitt and Whisler, "Management in the 1980's," *Harvard Business Review*, November–December, 1958, pp. 41, 42.

Other discussions and speculations on appropriate organizational forms for modern industry are continually appearing in both book and article form. *The Human Side of Enterprise*, by Douglas McGregor, director of the Sloan Fellowship Program at MIT, is an important contribution to this discussion. It takes a less deterministic view of the effect of the new technologies on industrial organization. This book briefly reviews past approaches and then suggests new ones for dealing with the conflicts between technological and organizational imperatives and human needs.

In the real world of industry, many of the older ways of thinking and acting about organizational matters still persist. But more and more, progressive companies—especially science-based ones—have begun to experiment organizationally. The writer predicts a wider and wider influence of such experiments on the structure and dynamics of industry as a whole. Here is a fertile field for creative research, for invention, and for leadership.

One of the newest and most vital areas where both science and technology are calling for new organizational ideas and new concepts for leadership is in the research laboratory. To illustrate some of the problems in this field, we print the findings of a recent research project under the title "Scientists, Engineers, and Industrial Organization." Selected readings in this comparatively new field will be found in the bibliography.

As the final selection, we present a forward-looking memorandum which paints in broad strokes the shape of things to come in industrial organization under the impact of automation.

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1. TECHNICAL CHANGE AND SOCIAL STRUCTURE

From W. H. Scott et al., *Technical Change and Industrial Relations: A Study of the Relations between Technical Change and Social Structure in a Large Steelworks*, Liverpool University Press, Liverpool, 1956, pp. 5, 6, 9, 18–21, 31, 36, 75, 81–83, 94–100, 102–104, 107.

INTRODUCTION

There can be little doubt that the smooth introduction and assimilation of technical change in industry is of considerable public importance at the present time, and that it may become even more important in the near future. Technical progress during the last two hundred years has resulted in an astonishing increase in the production of goods and services, and in an impressive rise in the standards of life of all sections of the population. It seems clear, however, that the rate of technical progress in industry must be maintained and if possible accelerated, if the evident desire of people throughout the world for a continuing improvement in living standards is to be satisfied. Despite its long-term benefits, however, it is often suggested that technical progress is retarded by the resistances to change which are apparent in our society. It seems important, therefore, to ascertain why these attitudes develop, and whether it is possible to establish conditions in which different attitudes might appear. The present study represents an attempt to interpret attitudes to change in the light of a systematic exploration [undertaken in a single large steel plant] of the relations between technical organisation and social structure, and of how change in the one affects the other.

From the point of view of technology, the story [of this steel plant] is primarily one of advance from simple methods of hand rolling of sheets from puddled iron to continuous strip rolling of steel sheets with finely specified chemical and physical properties. Increases in scale and advances in technique have together brought about a progressive modification and diversification in the occupational structure of the plant—a trend which is particularly noticeable in the history of its managerial organisation.

[Before proceeding to a more detailed consideration of the impact of technical change in this specific case, however, it may be useful to outline in general terms] some of the more important ways in which technical change was considered likely to modify the various elements of social structure, and hence to influence the attitudes and behaviour of the persons involved. . . .

Occupational structure is usually affected directly, since, as the scale and complexity of mechanical equipment grows, the types of skills necessary, and the numbers of persons possessing each type who are required, must change. Two important trends in industry in general which have been observed are a reduction of the number of production workers who have acquired a high degree of skill by apprenticeship or by experience, and an increase in the number of skilled craftsmen required for construction and maintenance, as mechanisation develops. It has been said that technical change transfers rather than eliminates skill, but although this is true in a certain sense, it is important to note that the skills "transferred" are usually new skills, which implies the recruitment of new staff, or, when feasible, the retraining of those displaced. In addition to the two trends mentioned, technical change also appears to lead to a steady expansion of administrative, "staff" and junior managerial personnel.[1] Technical staff, production planning and control, costing, personnel and other managerial functions have grown and become more specialised as the complexity and interdependence of processes have increased, and this differentiation of function may create a need for more persons with ability in general management to undertake overall planning and coordination. As occupational structure changes, the relative rewards of the different groups may also change; in particular wages, chances of promotion, status and job satisfaction, all of which are related closely to occupation, may be affected, together with the distribution of power between occupational groups and the trade unions. This has an unavoidable impact on management-union and management-employee relations. Through its influence on occupational structure, it is clear that technical change may affect many of the factors that are central to the interests and aspirations of industrial employees, and we may expect therefore that their attitudes to change will be related to their experiences in this regard.

A minor technical change, involving only a slight modification to an existing process, may lead to some changes in informal structure, arising, for example, simply from a reduction in the number of employees required to man a modified process, and the consequent transfer of the redundant to other jobs. When, however, a change is more radical, and leads to a marked revision of the nature and division of work assignments, often with attendant changes in the nature and distribution of skills required, changes in the basis and composition of face-to-face groups will necessarily follow. On the old hand-rolling mills in the steel industry, for example, all the occupations and skills necessary for the rolling of sheet were represented in one team of ten men on each mill, although each team was dependent on the preceding and following shifts; in a modern mechanised hot-rolling mill, the process consists of a sequence of operations spread in a long line over a distance of several hundred yards, and sub-group formation is more likely to take place between men of the same occupation rather than between men of different occupations. Moreover, when technical change is of the magnitude exemplified by a change from hand rolling to a continuous hot mill, involving a great increase in the scale and complexity of mechanical equipment, it is also likely, consequent on the increasing specialisation within management that becomes necessary, to lead both to an expansion and differentiation of the sub-groups within management.

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[1] For a discussion of these trends, see W. E. Moore, "Social Consequences of Technical Change from the Sociological Standpoint," in "Social Implications of Technical Change," *International Social Science Bulletin,* Vol. IV, 1952.

In sum, it appears that over a period of time technical change leads both to a multiplication and an increasing diversity of sub-groups in a plant. If a process of change involves, as it often does, an increase in the scale of operations, this tendency will be accentuated. Insofar as men value continuity of association and stability of group relationships, and the security deriving from them—and, as pointed out earlier, some previous research has suggested that they do—marked changes in informal structure may influence their attitudes to change. Further, from the point of view of the social system as a whole, if technical change entails an increasing differentiation of sub-groups, it may complicate problems of communication, coordination and integration, and thus impede the assimilation of a technical change and the realisation of its full potentialities. . . .

Since the formal structure of the plant consists of elements which either have been prescribed by management or have become explicit and recognised through customary usage, they may not be directly or immediately modified by technical change. Indeed, there is evidence that formal structure tends to persist despite change in other directions, even when these changes may run counter to it. A simple "line" organisation for management, for example, based upon unity of command at each level, may persist although functional differentiation of management, with the contributions of various specialists being brought to bear on operating problems, makes it unworkable in practice; similarly, advancing occupational differentiation amongst both management and employees, with new skills being required particularly for supervisory, technical and administrative positions, may make a pre-existing system of strict promotion by seniority undesirable, but this may nevertheless persist. There are many examples in industry of wage structures whose principles have remained rigid despite considerable changes in the distribution of skill, responsibility and effort required in a work force. These considerations underline the importance of the degree of consistency between formal structure and occupational and informal structure in influencing the assimilation of change.

[We shall now look more closely at the impact of technical change on the managerial organization of the steel plant in an effort to see how some of the general effects of such change, outlined above, were manifested in a concrete instance.]

IMPACT OF THE NEW MILL

Changes in the Technology

[The introduction of the continuous strip mill, 1937–1946] was, without doubt, the most fundamental [reorganization] in the history of the plant. It was the first occasion that technical development had necessitated abrupt and radical change in the processes, jobs, and skills in so much of the works. Moreover, though the completion of a fully integrated steel plant was delayed until after the end of the Second World War, this was implicit in the decision to introduce continuous strip rolling, and the general effect was the creation of a larger organisation operating at a higher technological level.

Negotiations were opened with an American firm in 1937, for the supply and installation of a hot and cold strip mill. Work on the site began in the same year and, at the end of 1939, a hot mill, occupying a shop over a quarter of a mile long and a hundred feet wide, together with pickling, a cold reduction mill and other finishing units, came into production with a capacity of 10,000 tons of strip per week. Meanwhile, the closing down of the hand mills was begun and men were transferred to the new strip mill. The changeover was not, however, very abrupt. The demands of war made it possible to keep some hand mills in production and the last mill did not close down until 1946.

Thus, during the Second World War, the productive processes in connection with the rolling and finishing of steel sheets were radically modified, mechanised and elaborated to enable the company to satisfy, after the war, not only the traditional demand for black, galvanised and corrugated sheet but also the more exacting demands of the makers of pressed steel articles ranging from motor car bodies to refrigerators.

Functional Differentiation within Management

The introduction of the continuous hot mill led not only to the establishment of new production departments but also to the emergence of new "staff" services and to the expansion and differentiation of other ancillary functions. The sketch of the higher management organisation in 1954,[2] should be compared with the diagram for 1935. In 1935, there were ten departmental heads responsible to the managing director; in 1954, three of these (foundry, chemical works and bar mill) were no longer directly responsible to the works management, and three new production department heads (cold mill, blast furnace, coke ovens) had appeared in the higher management organisation. The total number responsible to the general manager in 1954 had, however, increased to twenty,[3] or exactly doubled, and this increase is accounted for entirely by the emergence of new specialist or 'service' functions. This process of differentiation has also occurred within departments, as will be seen later.

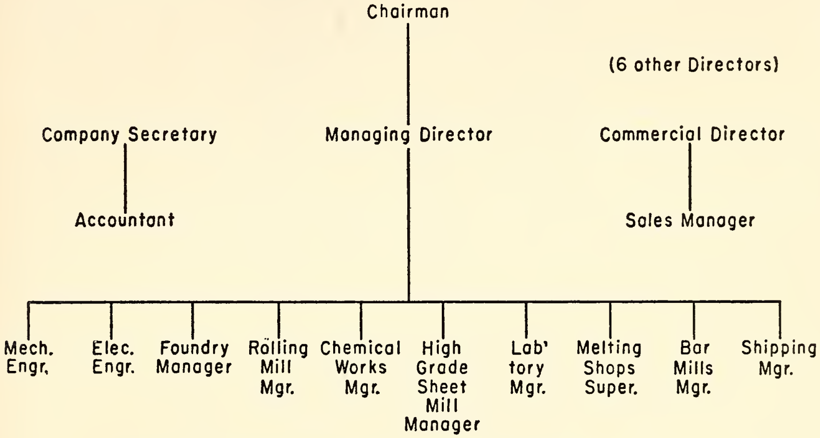
Chairman
(6 other Directors)
Company Secretary
Accountant
Managing Director
Commercial Director
Sales Manager
Mech. Engr.
Elec. Engr.
Foundry Manager
Rolling Mill Mgr.
Chemical Works Mgr.
High Grade Sheet Mill Manager
Lab'tory Mgr.
Melting Shops Super.
Bar Mills Mgr.
Shipping Mgr.

Figure 1. Formal Organization of Higher Management in 1935.

The increase of "staff" and service departments represents in many ways the most important and significant development. To some extent this is simply a consequence of the increased size of the undertaking and of the greater number of production departments, in the sense that increased size makes a more refined division of functions more economical and enables

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[2] This chart was constructed by the research team on the basis of interviews, and does not exist as such in the firm.

[3] Including the assistant general manager and the statistics and negotiation manager, who is shown on the chart as responsible to the labour relations director, since most of the work of his department does in fact come within the purview of that director.

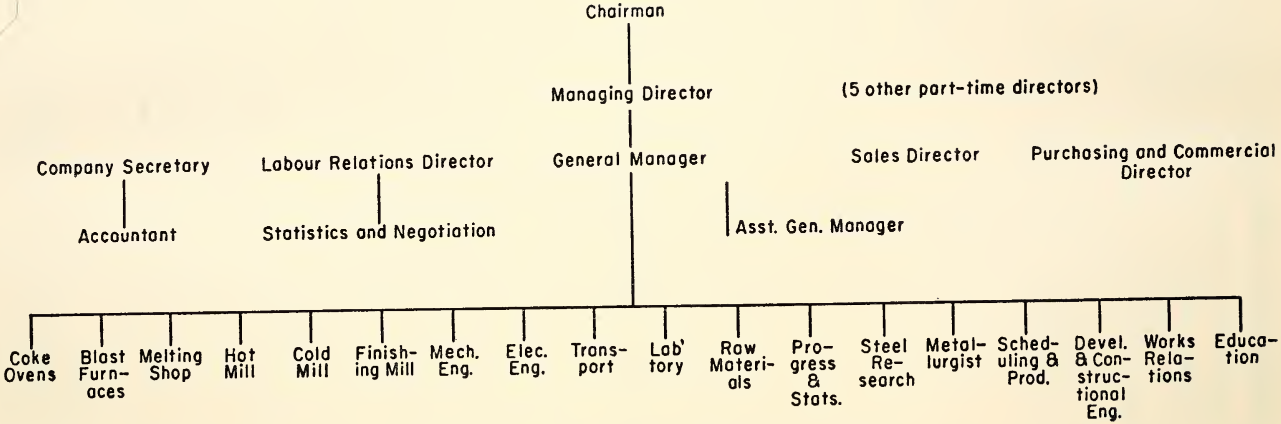
Chairman
Managing Director
(5 other part-time directors)
Company Secretary
Accountant
Labour Relations Director
Statistics and Negotiation
General Manager
Asst. Gen. Manager
Sales Director
Purchasing and Commercial Director
Coke Ovens
Blast Furnaces
Melting Shop
Hot Mill
Cold Mill
Finishing Mill
Mech. Eng.
Elec. Eng.
Transport
Lab'tory
Raw Materials
Progress & Stats.
Steel Research
Metallurgist
Scheduling & Prod.
Devel. & Constructional Eng.
Works Relations
Education

Figure 2. Higher Management Organization, 1954.

new functions to be supported; but the changes are qualitative as well. Thus the steady expansion of production units which has proceeded since 1938 justified the creation of a third engineering department, "development and constructional engineering," but this factor was reinforced by the knowledge that many of the engineering problems to be faced in the erection of new plant would be of a novel kind, not encountered previously in the experience of the firm. Similarly, the appointment in 1940 of an assistant general manager with special responsibility for coordinating the work of the established engineering departments and the rolling mills was prompted by recognition of the heavier burden falling on the general manager as the number of departmental heads increased, but at the same time maintenance of the new mills was presenting engineering problems of a more varied and complex character than before.

In other cases the influence of qualitative factors is more marked. The demand for high quality sheet, and consequently the need for higher quality and special steels, led to the establishment of "steel research" as a separate function, and to a considerable expansion and differentiation of the work of the laboratory. The "progress and statistics" department has a similar background. Its main function is to make detailed observations and records, from the ingot to the finished sheet stage, of any special rolling or experiment that may be undertaken from time to time, in an endeavour to detect how a fault has arisen or why a problem exists, and to provide data for changes in standard practices. The "scheduling and production" department derives from the close interdependence of the new units, which requires a steady flow of suitable material from one to another if continuous and economical operation of each is to be maintained, and from the wide variation in the contents of the firm's order-book, which demands both flexibility in operations and the maintenance of uniformly high quality. Its responsibility extends from the "slab" to the finished sheet stages, and it prescribes the dimensions of the slabs to be rolled from the ingots, the dimensions of the "strip" to be rolled from the slabs, and the subsequent treatment of the "strip" during cold rolling and finishing operations. The origin of another new "service" department, "raw materials," can be traced to the great increase in supplies needed for the new plant, and to the variety and different qualities of material required, whilst these factors, together with the increasing variety of orders that have to be executed, have led to a considerable expansion and differentiation of the accounting and costing function. The emergence of the remaining new functions is related to the changes in occupational structure brought about by the installation of the new mills. Commencing with the construction of the new hot mill, and continuing as cold rolling equipment was gradually introduced and as new units were erected after the war, it has been necessary to determine the rates and conditions for a constant succession of new jobs, and to effect transfers of men to them. The "statistics and negotiation" department was established in 1938 to undertake this work in collaboration with the production managers and trade union representatives concerned. The decision to establish the "works relations," or personnel, function although influenced by the changing climate of opinion about the human problems of industry during the war, was not taken finally until 1944, when the resettlement of those demobilised from the Forces had to be faced in the immediate future, and it was appreciated that many would be unable to return to the jobs which they had left during the first year of the war, a large number of which no longer existed.

This process of functional differentiation and specialisation, which gained momentum with the introduction of continuous rolling in 1939 and which has proceeded both at the departmental manager level and also within departments, has substantially altered the characteristics of the management group.

The Informal Structure of Higher Management

The dispersion of the plant, and the considerable distances which separate many of the departments, together with the pre-occupation of many of the senior managers with the post-war expansion have meant that interaction between senior managers, and the consequent informal structure, was very largely delineated by, and confined to, the immediate functional requirements of the formal and technical organisation.

[This] subdivision of the informal structure by departmental groupings and its limited development for the group as a whole, probably has both advantages and disadvantages. Whilst it may result in an excessive pre-occupation with the internal affairs of particular units on the part of their heads, and limit the development of an ability to make particular decisions in the light of the general policy of the organisation as a whole, it may also have countervailing advantages. It should promote effective cooperation between production departments which are closely related functionally, and it should limit the development of cross-sectional sub-groups or cliques based on extraneous criteria, such as a common social, professional or technical background, which might prove detrimental to cooperation for productive purposes.

Several managers averred that cleavages within the higher management group had been marked in the past, but this conflict was essentially between parallel and similar production units which [were] not very interdependent. The technical organisation is very different now, constituting, as one manager described it, "a long thin line of highly interdependent units." Relations between the various production managers seem to be more effective, at least between departments at adjacent points in the chain.

Technical change, however, whilst increasing the degree of specialisation amongst production departments, has also led to rapid functional differentiation of specialist and "service" departments and such cleavages as are present now tend to follow the line-staff or production-service split. The most marked was between production managers and their engineering counterparts. Several production managers commented that they would prefer departmental engineers to be responsible to them and not to the engineers; the engineers for their part complained of the production managers' persistent demands for small alterations, which interfered with long-term plans, or their tendency to raise matters at meetings rather than to deal directly with the engineers, and of the breakdowns due to the inability of "production people" to appreciate technical needs.

To some extent cleavages between production and service departments reflect the differing attitudes and backgrounds of the "professionals" and the "veterans," that is, of those who possess professional qualifications and who for the most part have been recruited as managers on the one hand, and of those who have risen "the hard way" and have no formal qualifications on the other.

[Although] cleavages between the "professionals" and "veterans" and between the managers of production and service departments other than engineering were not marked, they may present in the long run a difficult and intractable problem. Production and service departments are interdependent, and unsatisfactory relations between them may reduce the effectiveness of an organisation. Moreover, to say that in general cleavages are not marked is not to suggest that their activities are integrated as effectively as possible. In the present firm, the various production and service departments exist as parallel chains of command, and the formal organisation does not define the "horizontal" relations between them.

Formal Structure and Coordination

Coordination of the policies and programmes of the departmental heads is undertaken by the activities of the works management and through the medium of management meetings.

At the works management level, coordination depends primarily upon the general manager, although there are other full-time directors with special responsibilities who deal directly with the departmental heads on matters concerning sales, purchasing and labour relations [see 1954 chart]. The formal organisation, however, is minimal and is not defined precisely at these levels—there were, for example, few organisation charts—and the structure "has just grown up," as several managers said.

It is apparent that the departmental managers enjoy considerable discretion and that, subject to decisions taken at management meetings, they are left to a large extent to manage their own departments in their own way. Nevertheless, some of them feel that the present higher management structure is too highly centralised. The explanation probably lies partly in the almost inevitable pattern of the general manager's intervention and control. Given his wide "span of control" [19 senior managers are responsible to him], he has to concentrate on "trouble spots," and to focus his attention on particular departments at different times. Thus a manager who is master in his own house most of the time knows that at any time the general manager may expect him to supply accurate information or satisfactory explanations. The absence of any fairly precise definition of the allocation of authority and responsibility may also contribute to feelings of uncertainty [on the part of departmental managers].

The formal arrangements are therefore minimal and *ad hoc*, and it is probable that the present position represents the persistence of a pattern from an earlier phase of development which was marked by informality in relationships and by a close personal link between members of the [owning] family and the operating managers.

During the past two decades, however, the organisation has not only grown considerably in size, but has, as we have seen, become highly differentiated. In these circumstances, it is possible that a more systematic coordination of the work of the senior managers is desirable. Our examination of the informal structure of higher management showed it to be departmentalised, and it may be necessary to develop a greater awareness, on the part of its members, of the identity and functions of the group as a whole; this would promote more effective day-to-day coordination and also facilitate long-term planning. Moreover, existing values, which play down the importance of formal arrangements for coordination, may place a heavy burden on the relations between colleagues. During a period of rapid change, departmental heads have often of necessity been preoccupied almost exclusively with the problems of their own departments. In these circumstances, the needs of other departments may be overlooked when decisions are taken, or, if the endeavour is made in framing decisions to take account of the needs of the organisation as a whole, legitimate differences of opinion can arise. This situation may tend to strain relations between colleagues from time to time. Finally, there is the question of the relations between production and "staff" or "service" departments. No serious general problem appears to exist, but a clarification of roles and authority might be beneficial, particularly as experience elsewhere suggests that problems of line-staff relations can become more acute when an enlarged and highly differentiated organisation enters a phase of consolidation.[4]

[4] See Ernest Dale, *Planning and Developing the Company Organisation Structure*, American Management Association, 1952, pp. 67–83.

[In short,] the advent of new production departments and the considerable development of "staff" and service functions has complicated administrative problems. Traditional values, which stressed informality, a minimum of formal organisation, the individual responsibility of managers, and loyalty to family and firm, may no longer be adequate. The differentiation of functions, of occupational structure and of informal structure may have progressed to the point where a minimal formal structure and traditional values no longer ensure adequate cooperation and coordination. Although the developing professionalisation of the management may mean that resistance to change itself is less likely to develop within the management ranks, on the other hand the assimilation and full exploitation of recent and future changes may be retarded if effective integration of the structure is not maintained.

2. THE LOGIC OF AUTOMATION

From Melvin L. Hurni, "Decision-making in the Age of Automation," *Harvard Business Review*, vol. 33, no. 5, pp. 49–58, September–October, 1955.

What is the significance of mechanization and automation in the new era?

The widespread attention that has been given to the use of automation in the automotive industry should be an indication of its feasibility for larger, though fairly simple, production systems. However, it needs to be emphasized that the well-known examples from Ford, Chrysler, and General Motors, spectacular as they are, by no means tell the entire story—on two accounts:

1. They obscure from attention even more fundamental advances in the use of new materials or forms of materials that may substitute a single piece for a completed assembly, thus (a) eliminating entirely any need for automation of such an assembly, and (b) providing means for much simpler mechanization, as in the form of a single machine.
2. The more spottily reported piecemeal approach to automation gives a more realistic picture across industry generally than does the large-scale mechanization of the automobile industry.

Under the piecemeal approach, small portions of the total system previously utilizing sequences of individual machines have been grouped into a single mechanism. Again, similar sequences have been tied together with familiar transfer devices. It is the creeping approach, in other words, and the total impact of it is lost through familiarity.

Potential Advantages

The competitive advantages of automation are frequently cited and should be well known. They include:

1. *Increased productivity,* an important tool in a competitive market and an important factor for the future if the wide predictions of shortages of labor continue to become more of a reality.
2. *Uniform quality.*
3. *Better control of the flow of production,* as a result of rigid mechanical sequencing to which human judgment or whim may only be applied at the input end or to the whole system.
4. *Reduced running costs,* which come as a consequence of the other factors above.

In the possession of a thoughtful competitor, automation can be a devastating approach and one which it would be most difficult to copy. Indeed, to mimic the physical appearances of automation may be the least important thing and a most dangerous procedure, because once in place an automated process is relatively inflexible, as well as costly in terms of the capital so tied up.

The true roots of automation lie not in the mechanical feasibility of replacing hand operations but in the logic of an over-all system of operation. And this logic, in turn, is grounded not in manufacturing alone but in marketing and engineering design as well. In a typical multi-product business, for instance, automatic operations are predicated upon expected variations in volume, product mix, quality, and demand; and the designs assume flexibility in assemblies rather than in parts to meet the demands of the market.

Dangers of Inflexibility

Inevitably, the integration of market interpretations and engineering designs into a plan of manufacturing carries with it some risks as, for example, lack of ability to meet other than certain prespecified customer demands.

An automated system is based on an expected performance of the market and on an expected performance of the processes of production. There should be full recognition on management's part that:

1. Expected performance does not occur every day or week, if it occurs at all in any given period of time. Roughly speaking, expected performance is only some kind of averaging of actual performance. Thus, it may be almost certain that during the next ten years motorboat ownership will double; but annual sales of individual firms are even more certain to be sporadic.

2. Although business phenomena may change slowly, they do trend in time toward a new set of conditions that must be described in terms of a new average performance. Thus, the development of synthetic fibers did not immediately affect most textile companies, and for many years changes in marketing and production seemed to move slowly; but there came a time when the typical firm could no longer go on using traditional processes.

3. Such a trend is usually cumulative, and at some particular time demands drastic and costly revisions of facilities, methods of operation, and form and staffing of the organization structure if success is to be continued.

With production built so logically and rigorously around the expectation of an average or typical situation, physical facilities are literally tied together in fixed sequences with little flexibility. To attempt to add additional flexibility by breaking fixed sequences may well destroy the system itself.

These modern systems are particularly sensitive to changes in volume and product mix and are typically designed for a fixed and predetermined range of output. Accordingly, they are usually profitable only within a limited range of volume and a narrow band of product mix and with an essentially fixed product design. For this reason, automation has been used for such high-volume, fixed-design products as engine blocks or television chassis, for example, but not for the assembly of large steam turbines or industrial control panels.

The dangers of inflexibility are complicated by two consequences of any highly mechanized system:

1. The ratio of indirect to direct labor, as now defined, will markedly increase. Even today many of those people whom we continue to consider as "overhead" workers are in reality production workers as vital to continued operations as the men on the machines, and maybe we ought to revise our traditional concepts of indirect and direct labor.

2. With more elaborate machinery (and risk that business phenomena will not remain stable long enough to pay off the investment), the amount of cost that can be controlled in terms of short-run economic changes will become smaller and smaller. Indeed, this may make dependence on any device like variable-cost control actually hazardous.

Need for Rigorous Planning

Automation—or, for that matter, mass production "new style"—demands a conceptual period of greater length than heretofore required in laying out manufacturing facilities. Also, except in the case of inherently simple product lines, it requires more systematic analysis of the market, of functional specifications for product, of engineering designs, and of the cost and relative flexibility of alternate manufacturing schemes than is usually made in designing the more conventional shop that we have all become familiar with.

Moreover, the inherent rigidity of an automated system must exist during the whole economic life span of the automated equipment. Modifications to meet changing conditions are, more often than not, difficult and costly. Automation, therefore, usually imposes on management the need for not only a longer and more rigorous planning period prior to installation but also a longer period of risk without the benefit of marginal correction. The evaluation of the opportunities and the risks thus demands a higher order of rationality than was previously required.

Nor does the unorganized piecemeal or bit-by-bit approach offer much consolation. Here the individual pieces may be understood, but the over-all system grows like Topsy, unguided, with knowledge of over-all risks, bottlenecks, and imbalances discovered only through operating experience.

Typically, the modern production system involves a high first or capital cost with continuing high fixed annual charges. This shifts the mix of costs away from high running expenses to higher capital outlays. The true advantage is realized only over a period of time when the difference in the cumulative sum of capital and running costs between the modern and the traditional systems shows up.

The executives who make the decision to install automation (or mass production "new style") thus commit their company to a relatively rigid production system in a technological and marketing situation that may be quite fluid. Their decision, therefore, projects further into the future and also has higher impact than usual because of its degree of irreversibility. Whereas today they are deciding, say, to install a battery of single-purpose machines designed to perform certain operations more economically for a specific design of product only, in a more traditional shop they would have had the work done on general purpose machines which could have been converted, if necessary, to manufacture a differently designed product altogether.

Yet the pressures of a competitive market and the expectations of our industrial society demand that the business manager move increasingly in just this direction.

3. TECHNOLOGY IN A MODERN SCIENCE-BASED COMPANY

From R. J. Cordiner, *New Frontiers for Professional Managers*, McGraw-Hill Book Company, Inc., New York, 1956, pp. 26–36.

From the time of Edison, this [General Electric] has been a technical Company which has made a business of science and invention. A few other companies had early laboratories devoted to product development and working out manufacturing processes, but in 1900 General Electric established, under Dr. Willis Whitney, the General Electric Research Laboratory—the first industrial laboratory devoted to basic scientific research into the mysteries of nature.

Today, General Electric employs 18,000 technical graduates: 15,300 engineers and 2,700 scientists. To put these figures into perspective: in 1900, industry employed one engineer for every 250 employees. In 1952, the figure had risen to one engineer for every 60 employees. In General Electric, one out of every 13 employees is a scientist or engineer.[1]

General Electric has 42 full-scale laboratories, plus great quantities of laboratory equipment, computers, and instruments in many other locations. Since the last world war, the Company has expended $175 million in research and development laboratories. It has also invested more than a billion dollars in the most modern plant and equipment to assure manufacturing leadership as well as research and engineering leadership.

Taking Long-term Risks

Having these technical skills and facilities, General Electric also has the capacity—and the inclination—to take large, long-term risks in introducing new products, new businesses, and ultimately new industries. This risk-taking characteristic is based on two important factors.

First, the Company has had extensive experience in managing innovation. While each innovation is an adventure, we are developing patterns of managing and of action which enable us to reduce the risk, or at least calculate it better, and also to reduce the time involved in bringing new products and systems to market profitably.

The second factor in risk-taking is the Company's financial flow, which arises from its diversity and scale of operation in the economy's competitive market places. The relative stability of General Electric's total sales volume and profit makes it possible to invest in the development of products and markets which may be years in reaching a state of profitability.

"Growing from Within"

The emphasis on technical innovation and risk brings us logically to the next characteristic of the Company: General Electric "grows from within." The Company is expanding not by merger or purchase of other companies, but by developing new products and markets, and hence new businesses.

Experience has taught General Electric people to see each product as a type of organism, with a life cycle of its own. There is the laborious process of bringing a new product to birth, from its abstract beginnings in scientific thought or in some salesman's perception of a customer need. Then the expensive period when this new product, like a child, is not fully developed and not able to support itself. As the Company is able to develop a market—the product enters a growth period, when other companies are all too happy to join in the process of competing for a share of the new market. As the product becomes established, the Company must keep renewing it with fresh innovations and features. And finally, some totally new approach makes the product obsolete and it must be retired from the line while new products are brought on the market.

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[1] Because of the large number of engineering and other functional skills required in General Electric's operations, payments to employees are about 41% of the Company's total costs.

Thus, the Company is in the business of both innovation and obsolescence. We are attempting always to make non-electrical ways of doing things obsolete, and even to make our own products and processes obsolete with new ones.

Diversification

As a natural result of being in the electrical business, with a long tradition of research and innovation, General Electric may well be the most diversified Company in the world. Surprisingly, it is almost impossible to say how many different products the Company manufactures because it is impossible to get agreement on just what a "product" is. For example, consider the circular fluorescent lamp and the straight fluorescent lamp. Are they two products, or one product? Is a pink fluorescent a different product from a yellow-tinged one?

One brave soul ventured the estimate that General Electric manufactures 200,000 separate products, and it is a statistical fact that the Company lists more than 3 million catalog numbers to differentiate various sizes, shapes, and ratings. As far as bookkeeping is concerned, separate operating records are kept today on about 350 lines of products, and there are nearly 100 product-manufacturing operating departments,[2] as well as numerous distributing and selling departments.

Yet, in spite of the tremendous variety, these are not miscellaneous or unrelated products. All these products have their base in the fundamental business of creating and serving the market for equipment to make, transmit, distribute, and use electric power.

What has happened is that, although the Company started with the basic technology of electrical engineering, the technologies diversified as its engineers ran into new technical barriers. For example, our designs very early encountered technical limits in insulating materials. The Company needed insulating capacities that were not commercially available, and was thus obliged to enter into chemical research in order to develop its own special materials. Likewise, many of the Company's products from lamps to turbines have from the beginning been limited primarily by the kinds of metals that have been available. So, in order to produce more efficient turbines and to provide the customer with a lamp that will give more light for his money, General Electric has engaged in metallurgical research and has become a producer of special metals.

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[2] On the average, each one of the departments is equivalent to a $30 to $40 million company.

Thus, as we overcome new scientific and technical barriers, we see a merging of old technologies, the rise of new technologies, and the growth of fresh businesses which have an actual, but not always obvious, basis in the primary technology of producing and utilizing electric power.

This flow of scientific discoveries and new business opportunities has given General Electric a logical interest in some of the promising new fields of the future: industrial electronics and automation; air conditioning and the heat pump; gas turbines; rockets and guided missiles; atomic energy; the high-strength, heat-resistant metals, ceramics, and chemicals; and the ever new and challenging field of electrical appliances and equipment.

The Company's fortunes are intricately related to the factors shaping the economy and society. Management is therefore obliged to anticipate long-range changes and compute their effect on the business.

4. IMPACT OF AUTOMATION ON ORGANIZATION AND THE INDIVIDUAL

From F. C. Mann, and R. L. Hoffman, "Case History in Two Power Plants," in *Man and Automation: Report of the Proceedings of a Conference Sponsored by the Society for Applied Anthropology at Yale University, December 27, 28, 1955*, Technology Project, Yale University, New Haven, Conn., 1956, pp. 54, 55, 57–65.[1]

Anticipating a greater demand for electric power in its service area, an electrical light and power company expanded its production capacity recently by adding a new power plant to its system of older plants. In the design of this new plant, the company incorporated many of the latest engineering advancements. As a result of these equipment changes, the new power plant has many characteristics of the automated factory of the future. These characteristics led us to study the new plant as a prototype of automation.

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[1] This case history by Mr. Mann and Mr. Hoffmann relied heavily upon charts in its original presentation. For reproduction here the authors have preferred to substitute a paper which covers the same ground and which has also been published by them, under the title, "Individual and Organizational Correlates of Automation," in *The Journal of Social Issues*, "Human Relations Research in Large Organizations, II," Vol. 12, No. 2, 1956. [For a fuller treatment see Floyd C. Mann and R. Hoffman, *Automation and the Worker*, Holt, Rinehart and Winston, Inc., New York, 1960.] James Dent and Thomas Lough made significant contributions as members of the research team on this project during its initial phases. Odile Benoit has been a major collaborator during the analysis phase.

Our study has focused on the perceptions and attitudes of the workers in this new plant. Not having recent measures of the characteristics of these men, we could not evaluate the actual changes in their attitudes resulting from their new working conditions. The decision was made to compare the attitudes of the men in the new plant with those of a similar group of men in an older plant in the system, where relatively few changes have taken place.

Approximately two years after the beginning of operations in the new plant, questionnaires were administered to the men in both plants. Questions were constructed to assess the men's perceptions and feelings about their working conditions, their jobs, their selection and training, shift work, supervision, and the company in general. The study had the support of the managements in both plants and of the union officials representing the men in the older plant. The men in the new plant were not organized.

IMPACT OF ENGINEERING CHANGES ON THE ORGANIZATION AND ITS PERSONNEL: SOME PRELIMINARY FINDINGS

The first findings from our study of some of the dimensions of the human problems which may accompany automation suggest that this form of technological change will have both positive and negative effects on workers' lives, their job satisfactions and motivations. In the new plant the more highly automated, unit system of production has brought about significant changes in the occupational and organizational structure of this plant, as compared to the older plant.

Reduction in Work Force. The first impression a visitor to the new plant receives is one of a large amount of gigantic, expensive equipment going full blast, but with very few men apparently responsible for its operation. This impression is not an illusion. The personnel requirements of the new plant, relative to its productive capacity, are about half what they would be in the older plants. This reduction in the number of workers needed has taken place principally in the operating jobs. In this plant, there is greater reliance on machine than on human control systems.

Part of this reduction in the number of operating personnel has been effected in the boiler feed pump and valve operations by the simplification of the system and the improvement in the feedback controls described previously. The regulation of the speed of the pumps and of the opening of the valves is now performed automatically under the control of a pneumatic feedback system. Because of these changes, the specific jobs of Auxiliary Operator and Water Tender no longer exist. Any work on the pumps which might be required is performed by helpers, but these occasions are rare.

The job of Flue Blower-Ash Handler which exists in the older plants has been, in part, replaced also. In the description of the flue-blowing process, it was noted that an operator in the new plant directs this process remotely by an automatic, programmed device. The Flue Blower-Ash Handlers do this dirty job manually. The ash handling—removal of ashes from the furnaces—is still manually controlled by the helpers in the new plants.

A further reduction in the number of operating personnel has taken place in the control rooms. Whereas nine men are used on the electrical switchboards in the older plant, only two are specifically responsible for this operation in the new one. Similarly, many fewer personnel are used in the unit control stations than operate the turbine and boiler sections of the old plant. Many functions, such as maintaining the steam temperature, are now done automatically without operator control. This reduction has also been accomplished by the reorganization of the work which accompanied the centralization of control of the boiler-turbine-generator operations in the unit control stations.

The effects of these reduced personnel needs are reflected in a greater feeling of job insecurity for the workers in the older plant. These men recognize that technological developments will soon force them to acquire new skills or to supplement their present skills with others required in the operation of new high pressure equipment. The greater efficiency of the new plant is underscored as it is operated continuously at full capacity. Cutbacks in the load requirements and the work force on the week-ends in the older plant have made it clear to all the workers there that the efficiency of the new plant may affect their future markedly. Four out of five of the men in the older plant report they are likely to be laid off if business conditions in the service area of this utility were to become worse. Only one out of five of the men in the new plant have equivalent fears about their future job security regardless of economic conditions.

An extensive reorganization of the content of jobs accompanied the integration of the boiler-turbine-generator operations and the centralization of their control. The job of "operator" has been redefined and enlarged to include a knowledge of and responsibility for the three major parts of the production system rather than merely a specialized concern with boiler, or turbine, or electrical operations.

In the older plant there is a high degree of job specialization related both to the type of work and to the degree of skill required. There are three major operating job groupings—boiler, turbine and condenser, and electrical. The job classification of the most highly skilled electrical job, Switchboard Operator 1st, is three grades higher than the grades of the most highly skilled turbine and boiler jobs, Turbine Operator 1st and Fireman, respectively. Jobs are also classified within each grouping by the degree of skill required. For example, in the boiler room in the older plant in this study there is the following hierarchy of jobs in order of *ascending skill requirements:* Flue Blower-Ash Handler, Fan Operator, Water Tender, Assistant Fireman, and Fireman. Similar skill hierarchies are present in the turbine and condenser rooms as well as in the electrical control room.

In the new plant the integration and centralization of operations and their controls dictated the combination of the jobs of the boiler and turbine operators into a single enlarged job. This enlargement required by the engineering changes set the stage for management to consider the advantages of further job enlargement. This consideration resulted in a decision to add the electrical operating jobs to the new boiler-turbine combination to ensure the development of personnel trained in all three functions. The only operating job classifications are A, B, and C Power Plant Operators. This organization of jobs is a hierarchy based on degree of skills alone. The older distinctions according to the particular equipment operated have been wiped out.

The A Operator is the most highly skilled classification. Each of these men is expected to have most of the skills and, especially, the knowledge and information previously held separately by the skilled boiler, turbine, and electrical operators. As his job title suggests the Power Operator A must be capable of running all of the major parts of the production system. The B Operator is a less skilled worker, in the process of acquiring proficiency on all the operations. Each B is paired with an A in his work, as he takes work orders and is trained by the more skilled man. The C Operator is really a helper. He performs the low-skilled, less desirable tasks which still remain after mechanization, under the informal direction of a B Operator.

The men who were A and B Operators at the time this study was conducted had transferred from operating jobs in the older plants, where they had performed specialized jobs in one of the three production rooms—boiler, turbine and condenser, or electrical. Each of these men had to learn new parts of the production process to a degree almost equal to the skill they already had in their own specialty. Former electrical switchboard operators now had to learn the steam side of the plant; former boiler fireman, the turbine and electrical; former turbine operator, the boiler and electrical.

As part of the on-the-job training for this job enlargement, job rotation was instituted. The men were rotated weekly between the unit control stations, the electrical control station, and other duties in the plant. Rotation has been continued even after the formal training was completed, so that, at the time of the study, the attitudes of the men towards their jobs were affected both by the fact that the job requirements had been vastly expanded over their previous jobs, but also by the fact that they changed the particular job they were doing for another one every week.

The effects of this job enlargement and rotation are marked. A significantly greater proportion of the men in the new plant report that their jobs are much more interesting and that they are more satisfied with the jobs they are doing than do those in the older plant. This feeling seems to arise generally because their jobs are more challenging. Moreover, more men feel that their jobs fully utilize their abilities. Another part of this greater satisfaction lies in the reduction of the monotony of the jobs permitted by job rotation. Each week the operators are faced with a different responsibility in a geographically and physically different job setting.

On-the-job rotation was only one part of a formal training program the company established to ease the transfer of men from their old specialized jobs to the new enlarged ones. The program ran the gamut from classroom sessions in the theory of operations, given by the technical engineers of the plant, to on-the-job training in all aspects of operation. Visits to other plants to observe particular parts of the production process in operation were also included. Despite this elaborate program, the men were generally agreed that they learned most about their new jobs from doing the jobs themselves while actually running the plant.

Tension and Interdependence. More men in the new plant than in the old plant report they feel jumpy or nervous about their work. This tension reflects both the enlargement and the feeling of inadequate training. More than a third of the operators report that their training for these new enlarged jobs was too fast, and that it took more than a year for them to feel at ease on their jobs.

Another factor related to the men's feelings of tension on the job is the degree to which they depend on each other for information about the system. Because they found they learned most about the jobs while actually doing the operations—rather than from the formal class-room parts of the training program—the former steam men relied on the former electrical men, and vice versa. The greater the tension level, the more the men report relying on the other men for suggestions and advice about the particular work problems they face on the job. There seems to be some optimal level of interdependence for the men in these plants. Too much or too little leads to some dissatisfaction with the job itself.

Reduction in Physical Isolation. Change in physical plant design has also affected the patterns of association among the men. The centralization of the control systems onto one floor in the new plant has brought the greater part of the operating personnel together at three stations. The design of the new plant has virtually eliminated the physical isolation of some of the jobs in the older system, where, for example, the Fan Operator spends his entire working day on the top floor of the plant, seven floors apart from most of the other men. This change in location of jobs gives the men more contact with each other, more chance to talk with others on the job. Although no direct measures are available on this, there is strong indication that the men feel a greater unity, more like a single group than they did previously.

Change in Supervisory Structure. The change to the unit system of operation, the accompanying enlargement of the jobs of the A Operators, and the placing of the major control stations on one floor, have resulted in a reorganization of the supervisory structure. In the old plant, each shift has at least one boiler room foreman, a turbine and condenser room foreman, and an electrical operating foreman. Each foreman also has an assistant. These men report to the Operating Engineer, who is in charge of coordinating the activities of 50 men through these foremen, and is responsible for running the entire sytsem on a particular shift. The Operating Engineer is in charge of the total plant during the evening and night shifts. He reports to the Plant Operations Engineer, who is a member of the top staff of the plant.

In the new plant, a single foreman (the Operating Foreman) is responsible for operations in the plant, and is in charge of the total plant during the evening and night shifts. He reports directly to the Plant Operations Engineer. There is no longer any need for an Operating Engineer to coordinate the boiler, turbine, and electrical functions. This level of supervision has been eliminated. Thus, the introduction of automation into this power plant has resulted in a streamlining of the organizational structure through the elimination of a level of supervision.

The Operating Foreman in the new plant does not directly supervise all of the men on his shift. He relies on the A Operators who have considerable knowledge of the operating process to direct the work of the B and C Operators. This organization of the direction of the work allows the A Operators to learn the human relations skills required to supervise people while they acquire technical knowledge about the equipment.

Patterns of Supervisory Behavior. Although a reduction in the number of workers and supervisors needed was easily anticipated by the forecasters of automation, there has been considerable speculation concerning the kinds of supervisory abilities which will be important. Some writers have suggested that technical proficiency will be the major stock in trade for the new supervisors. Concern for human relations will be minimal in the face of the new complicated equipment to be run, and the many fewer people to be supervised. Another group has said just the opposite. They claim that the workers will be the people who need the technical skills, and the job of the supervisor will be even more to supervise—to plan ahead and to maintain high morale and motivation among the workers.

Although our data offer no clearcut answer to this problem in prediction, several relevant findings should be mentioned. Those supervisors who are seen as most satisfactory by their subordinates are also perceived as being the most capable on *both* the technical and on the human relations side of their jobs. Those supervisors considered unsatisfactory are rated low in proficiency on technical and human relations skills. Among those supervisors who were rated as intermediately satisfactory, those who were perceived as competent in human relations, but not in technical ability, more often were considered satisfactory by their subordinates than the supervisors who were seen as good on the technical side but poor in human relations. Using the satisfaction of subordinates with their supervisors as the criterion, then, the good supervisor seems to combine both technical and human relations skills, with human relations ability being the most important. This seems to be equally true in the two plants.

Centralized Maintenance. While the maintenance of the equipment in power plants has long been on a preventive rather than a "crash" basis, the introduction of the unit system forced management to reconsider and, ultimately, to redesign the organization of plant maintenance. Before the unit system was installed, maintenance had been an in-plant function. Each man in the maintenance crew was a skilled craftsman—mechanic, electrician, pipe fitter, welder, boiler and stoker repair man, etc.—in a particular trade. In his maintenance activity he performed specific repairs. Under the unit system, when any part of a "unit" is incapacitated, its entire production is lost to the system. In order to minimize the "down time" for the new units, the major maintenance work has been removed from the individual plants, and made the responsibility of an enlarged department of construction and maintenance. The men in this department are usually engaged in the systematic overhaul of equipment and preventive maintenance. They move from plant to plant throughout the year. When an emergency arises, however, the entire group can swarm into the plant to make the necessary repairs as quickly as possible. The men in these construction and maintenance crews have retained their job specialties and particular trades.

Small repair jobs within each plant are still done by in-plant maintenance groups. Within these groups, however, old lines of specialization have been eliminated by combining five maintenance skills for the job of General Mechanic "A." The objective here has been to build multiple-skilled units in which each man is capable of doing several job specialties.

Some of these changes were strongly resisted by the union, but were eventually supported in arbitration. The difficulties met by the company in implementing this reorganization of jobs suggest the possibility that job changes of this order, if done too quickly, may be seen as job degradation rather than job enlargement, and decrease rather than increase work satisfactions.

Continuous Operation. Earlier we indicated that the increased capital investment may force automated factories to operate around-the-clock. The smaller work forces which are needed to man these factories will be asked to man them 24 hours a day. Since the production of electric power is a continuous process, our study allowed us to examine some of the problems of shift work. Moreover, the two plants which we contrasted have two different patterns of rotating shifts. One plant uses four shifts on a weekly pattern, while the other uses three with monthly rotation. These differences permitted comparisons of their effects on the lives of the workers involved.

The results of our study indicate that very few shift workers (six percent) actually like shift work. The most favorable attitude expressed by any sizeable group in this regard could only be interpreted as a tolerance for ("I don't mind") shift work. Most of the men dislike working shifts. Shift work creates problems in the worker's physical well-being, his relations with his family, and his relations to his larger social world of friends and entertainment. Our findings suggest that the physical and social costs of working shifts are great.

We find a difference, however, in the workers' tolerance for one shift pattern over the other. The weekly rotational pattern used in the new plant was more tolerable to the shift workers there than the monthly rotational pattern was to the workers in the old plant. Although statistically significant, this difference was small. Even under the weekly rotational system, the majority expressed a distaste for shift work.

The change to centralized maintenance also resulted in the institution of shift work for workers who had previously worked only days. To avoid shift work, many maintenance men chose to remain on the in-plant staffs rather than join the centralized group.

It seems clear that unless some ingenious alternative solutions are developed for easing the difficulties imposed by shift work, this aspect of automation will have generally negative effects on workers' lives.

SUMMARY AND CONCLUSION

The objective of this study has been to explore some of the individual and organizational correlates of automation. It has been our purpose to determine some of the social and psychological dimensions of this type of technological change. Toward this end our first study has been in a new, highly automated power plant. We chose power plants because their continuous production has long had many of the engineering characteristics of the new technology; we chose to study a *new* power plant because its changes in design and control appeared to be even more typical of new automated plants.

The introduction of automation into this power plant has produced major effects on its organizational structure and on the attitudes of the workers toward their jobs. Maintenance has been centralized for the entire system. Fewer levels of supervision are required for the smaller work force in the new plant. Job enlargement and rotation have resulted in greater job interest and satisfaction, but also in a higher tension level on the job. The effects of continuous operation on the workers' lives were generally found to be negative.

The findings in our study provide some indication of the dimensions of change which have accompanied automation in this one particular situation. Some of these changes were dictated by the new engineering design and controls; others were instituted by management as they attempted to create the most effective organizational machinery to meet the demands of the new technology. It should be emphasized that the effects we have described may be specific to the particular situation. For example, the extent to which the operating jobs were enlarged in this plant was a management decision and was not forced by the engineering changes. Automation introduced in a different situation and in a different way will presumably have different effects. This study suggests some of the dimensions of the psychological and social problems to be investigated more intensively; other exploratory studies will be needed to uncover other areas.

5. ENGINEERING LOGIC VS. SOCIAL REALITIES

From F. J. Roethlisberger, *Management and Morale*, Harvard University Press, Cambridge, Mass., 1947, pp. 36, 37, 143–146, 53–56.

Perhaps the chief characteristic of the technologist group of persons is that they are experimentally minded. They think in terms of the logic of efficiency, and they scrutinize everything that comes within their scope in these terms. This group is constantly striving to make improvements in machines, mechanical processes, and products. Sometimes they devise ingenious ways of bringing the worker's actions in line with the logic of efficiency. If the assumptions on which such plans are based be granted, they are perfectly sound. Certainly the technologist has no intention of foisting an arbitrary set of rules upon the worker. In fact, most of his plans are designed to help the worker. Carefully thought out wage plans are intended to reimburse the worker with a wage proportional to his efforts. The simplification of his job, whether through a change in process, division of labor, or elimination of random movements, is supposed to make his work easier and less fatiguing. If fatigue is eliminated, the worker, theoretically, can produce more and can thereby earn more money.

Now it happens frequently that these logical plans to promote efficiency and collaboration do not work out as intended. From the point of view of sentiments, they involve consequences which sometimes defeat the logical purposes of the plan as conceived. Let me point out some of these possible nonlogical consequences. When skill is divorced from the job at the work level and put in the hands of a group of technologists, a situation is created whereby the worker is put in a position of having to accommodate himself continually to changes which he does not initiate. And not only is he asked to accommodate himself to changes which he does not initiate, but also many of these changes deprive him of those very things which give meaning and significance to his work. In the language of the sentiments, it is as if the worker were told that his own individual skills, his acquired routines of work, his cultural traditions of craftsmanship, his personal interrelations, had absolutely no value. Now, such nonlogical consequences have devastating effects on the individual. They make him feel insecure, frustrated, or exasperated. . . .

Among physicists, chemists, mechanical, civil, chemical engineers, and so on, certain characteristics are evident. Most of them are concerned with a particular, limited class of phenomena. The events with which their specialization is concerned do not involve the interactions of persons. They have a useful way of thinking about and a simple method of dealing with their own class of phenomena. Within this area their judgments are likely to be sound. Outside it their judgments are more questionable. Some of them recognize quite clearly this limitation. They do not want to be concerned with the human factor; they want to design the best tool, the best machine to accomplish certain technical purposes. Whether or not the introduction of this tool or machine will involve the layoff of certain employees, quite rightly, is not their concern as engineers. Their contribution, in terms of the skill they practice, is to improve from a technical standpoint the performance or utility of a machine, a tool, or a product.

These men are invaluable to the administrator in any industrial organization. Within their area of specialization, they have come to enjoy a certain autonomy. No administrator would attempt to dictate to them their theories or skills or judgments within their area of competency. In this consists the prestige they rightfully enjoy in most business organizations. To them we owe the new and powerful technology of modern industry. To criticize them for failing to take into account the social consequences of their own discipline is absurd. When, therefore, we describe some of the human consequences at the work level of technical changes brought about by engineers, this is not intended as a criticism of this group. Bringing into cooperative relation their particular skills with other skills is not their function; it is a quite different function performed by other groups in the organization.

The virtue of the engineers is that, for the most part, they know what they are doing and what they are talking about in their own fields. They have a strong appreciation of "fact" and "logic," but, more important still, they are likely to know within their own area what they do not know. As a result, with their blunt and direct remarks, they provide a welcome relief to some business conferences. Their sense of fact and logic, however, sometimes has a way of making for difficulties in their human associations. For them everything is likely to be fact or error. When they participate in or deal with phenomena to which these two categories do not so clearly apply, they are likely to go off the deep end.

Were it not that in a business organization engineers have to cooperate with other groups and that sometimes engineers move into administrative positions, this difficulty in understanding the nature of cooperative phenomena would make no difference. However, when an engineer becomes an administrator he becomes, whether he likes it or not, concerned with a class of phenomena to which his former speciality has no relevance. Some engineers recognize this and accommodate themselves accordingly; others do not—they continue to handle cooperative phenomena as if they were handling a machine, more often than not with disastrous results. But the point we are trying to make here can be better stated with regard to the second group of specialists—those in whose area of specialization the interactions of persons cannot be conveniently disregarded.

If things in this world were simple, it would seem that, just as the administrator has persons with clear-cut specialties to aid him in handling noncooperative phenomena, so he would have persons with other clear-cut specialities to aid him in dealing with the cooperative phenomena with which he is also concerned. But here things become complex and confused, for there are a number of specialties in business whose relation to a particular class of phenomena is not so clear. Although at times, by abstraction, a certain aspect may be conveniently separated out for independent and special study, the matrix from which this abstraction is made generally involves the interactions of people. At times, particularly when these abstractions are applied to the concrete situation, the interactions of people may be the most important variables. As a result, the working hypotheses of these specialists, particularly on their applied side, must be far less clear, distinct, and well formulated than in the more highly developed and exact engineering sciences. There is no simple way of thinking about or putting together the complicated events involved, and there is equally no simple method of dealing with them.

Many of the techniques and specialties whose purpose is to improve the efficiency of workers fall into this category. They relate in part to the securing of the economic purpose of the total organization and in part to the securing of the cooperation of individuals in attaining that purpose. Motion economy offers a good example. In a certain sense, there is a way in which a worker can assemble a certain number of piece parts with the fewest number of motions. By abstraction, this aspect of the worker's environment can be separated out for individual study. For many purposes it is a convenient and useful abstraction to make, and there is no question that in terms of it increases in efficiency can and have been made.

However, there is another aspect of the application of this abstraction which cannot be quite ignored: To what extent does the application of motion economy secure the cooperation of individuals? Is it "better" to have a worker who is efficient from the point of view of motion economy but dissatisfied as a person; or is it "better" to have a worker who is happy but not so efficient from the point of view of motion economy? These are clearly rhetorical questions. They have served their purpose if they show distinctly that in the application of motion economy to concrete work situations two different classes of phenomena are involved. The application of the most economical way of performing certain operations to concrete work situations involves individuals in their relations to one another. It involves attitudes, feelings, and sentiments. At times, these factors cannot be conveniently disregarded, as any motion economy expert in practice recognizes. From a technical standpoint, many things in business can be done more efficiently; but if in the process of introducing changes toward this end a strike is produced, what do we mean by "efficiency"?

MODERN INDUSTRIAL ORGANIZATION

There are certain individuals throughout the field of modern business who are giving attention to problems of human collaboration. It might even be argued that there are distinct groups of people—personnel organizations—who give their entire time to this problem. And yet if one looks carefully at these individuals or personnel organizations one is apt to find a strong tendency to separate the strictly technical problems of production and distribution from the human problems connected with work association. It would not be an exaggeration to say that the activities of most personnel organizations are largely based upon this very sharp separation of technical or economic matters from matters of human concern. Very seldom do such organizations act in an advisory capacity regarding technical practices of the company. From the economic viewpoint most personnel people are considered supernumeraries. Most of their duties are concerned with the routine carrying out of policies that have been settled by other groups or with settling as best they can human problems that have already been created. There is a tendency in modern industrial organization to separate the economic function from all the social interrelations and to believe that in the settlement of economic problems it is not necessary to consider any other aspect of human organization. The following are concrete examples from factory situations.

EXAMPLE NO. 1

A company in the process of reorganization found that it had on its hands approximately 200 people whose jobs had been so greatly simplified that their highly developed skill was no longer required. Fortunately, the company was then enjoying renewed business activity so that it was possible to reabsorb these people in other parts of the plant. The executives of the company felt that this problem could be solved by transferring these employees to new jobs whenever vacancies occurred in other types of work. At the same time management insisted that there should be no diminution in the "take-home." Workers should be transferred only to jobs on which they could earn as much money as they had been able to earn on their old jobs.

Now it can be seen that logic of management was very simple. It assumed that inasmuch as the worker was primarily interested in the "take-home," any transference to another job, regardless of its nature, in which the weekly pay was not affected would be satisfactory to the employee. This logic holds in many instances primarily because two jobs whose earnings are more or less the same carry with them more or less the same social status in the company. In this particular case, however, this assumption did not hold. It happened that many of the jobs which had been affected by the reorganization were in terms of the attitudes of the employees toward them, "superior" to those to which they were being asked to transfer. The reorganization meant transferring stock assemblers and storeroom keepers to simple machine operations or assembly work. The results were not satisfactory. Many employees who were given a choice of new jobs did not care to accept. Instead they preferred to stay on their existing jobs until conditions made it imperative to transfer, even though staying involved the risk of diminished earnings.

EXAMPLE NO. 2

Many times management makes certain changes based upon logical and economic considerations and then finds that the human interrelations which were also affected by the change create new and difficult problems. Let me take, for example, a company in which the primary manufacturing activities were divided into six functional units such as operation, inspection, production, etc. Each of these functional units had its own hierarchy of authority and interacted with the other functional units only at certain specified points in the manufacturing process. Although this type of organization secured excellent vertical control within each function, there still existed the difficulty of coordinating the activities of the various functions. This lack of coordination, particularly at the lower levels, resulted in manufacturing inefficiency. To obviate this difficulty, it became necessary to reorganize the company on new lines. A number of different shops were set up, the activities of each centering around a particular product which it manufactured from start to finish. Under this new plan each shop had its own inspection and production people, who were now expected to report to supervisors in the operating line organization. Logically, this new setup should produce the desired effect of coordination of functions and probably in time will do so. But at present the company is finding that it is much easier to coordinate these logical functions on paper than to coordinate the people carrying them out. It is easier to change the logical basis of organization than to change the routine human sentiments that are being violated by the reorganization.

Immediately following this reorganization, the production and inspection people, the former in particular, began to register many complaints. They found the lighting conditions in their new surroundings faulty; they did not like the common washrooms. They found fault with the lockers. Some of them went to extreme lengths in registering their dissatisfaction. One employee, for instance, refused to use the washroom on the floor where he worked and laboriously climbed several stories to use a washroom for office employees. But far more serious were the organizational difficulties that developed. There was a tendency for production clerks to short-circuit the new formal lines of authority. Instead of reporting directly to their immediate superiors—the operating supervisors—they were likely to go to production supervisors up the line.

An explanation of this situation may be found in the fact that the new organization had broken down the sharp distinction between office people and shop people that had existed under the old arrangement. In the old organization, production clerks had regarded themselves as office people. Their feeling of superiority to shop people was not merely a fanciful whim, for, although there were no written statements by the company to this effect, in all the minor distinctions and privileges which differentiated office people from shop people—lockers and washroom facilities, for example—production people were socially identified with office people. Under the new organization they felt that their status had been jeopardized; in terms of the customary interhuman relations they felt they had been demoted. Their complaints were an expression of this disruption in the social equilibrium to which they had become accustomed.

EXAMPLE NO. 3

The foundry department of a manufacturing concern employed some fifty men who were almost all highly skilled craftsmen and long-service employees. These workers prided themselves on their traditions and clung to certain privileges, such as smoking on the job, which were denied to other employees in the factory. According to the nature of their work, the foundry workers were differentiated into four groups. These job groups, according to the foundrymen themselves, were not of equal importance. Each had its own social values and its own rank in the social scale. One of these groups was dominant, and in this group three or four members rigidly controlled the rest.

About three or four years ago, in line with its general policy, the company put all the foundry employees on group piece-work. Up to this time, they had been on straight piecework. Management felt that, under group piecework, earnings could be distributed more equitably and that such an arrangement would divide among all the employees the responsibility for turning out a satisfactory product and for reducing the amount of scrap due to defective castings. Such was the logic of what should happen. What actually happened was something quite different. Total output, instead of increasing, went down. The problem of scrap, instead of being solved, tended to reappear and complicate other issues. The iron molders felt they were not getting what they earned. Those operators with high outputs felt they were carrying the less efficient men. Molders did not see why they should be penalized for parts that were broken by the chippers and grinders. Some of the men who had previously earned about $1.00 an hour now earned about $.75 an hour; this in spite of the fact that the new rates under the group payment plan were not in any way "tighter" than the old rates under straight piecework.

So management was faced with the problem of disentangling itself from the human complications of its own logic. The situation was far more complex than my oversimplified account has suggested. In essence, however, it was a situation of extreme resistance to a change introduced by management which failed to take into account the social sentiments of the foundrymen. To the foundry employees there were four different social groups—four different ways of life—which, under the new wage payment system, were no longer recognized. The foundry employees never ceased to petition management to put them back on straight piecework or, failing this, to divide them, at least for the purpose of payment, into the four natural job groups. However, for technical reasons, management found it impossible to make either of these two moves. As a result, the employees tried to force the hand of management by restricting output even at the expense of lowered individual earnings.

EXAMPLE NO. 4

Suggestion plans, according to the general logic of management, are intended to promote constructive thinking and cooperation of employees. In one company such a system was introduced. The method of administration was very simple. Suggestions handed in by the employees were considered by a committee, and suitable awards were made for accepted suggestions. Management believed that notice of these awards should be posted publicly on the bulletin boards in order to stimulate submission of suggestions and give the suggesters full recognition. However, the public posting of awards met with increasing dissatisfaction on the part of the workers. If a worker submitted a suggestion that either eliminated an operation, or so simplified or changed a work routine that rate revision was necessary, a great deal of social pressure was put on this operator by his fellow workers. Often a foreman discriminated against a worker who turned in a suggestion that improved a process for which the foreman himself was responsible. He tended to interpret such a suggestion as criticism of his work and either penalized the worker or tried to rearrange the process in such a way that the suggestion was no longer of value. Many disputes arose as to the distribution of the "windfall" when an award was made public. If the suggester owed money, claimants would appear and ask the company to effect a settlement. For these reasons, management finally had to publish awards by code number only, thereby nullifying in part the original intention of the plan. Management's logical method of promoting collaboration had failed to take into account other important aspects of this human organization.

THE SOCIAL ORGANIZATION OF INDUSTRY

These examples show that industry has a social organization which cannot be treated independently from the technical problems of economic organization. An industrial organization is more than a plurality of individuals acting only with regard to their own economic interests. These individuals also have feelings and sentiments toward one another, and in their daily associations together they tend to build up routine patterns of interaction. Most of the individuals who live among these patterns come to accept them as obvious and necessary truths and to react as they dictate.

If one looks at a factory situation, for example, one finds individuals and groups of people associated together at work, acting in certain accepted and prescribed ways toward one another. There is not complete homogeneity of behavior between individuals or between one group of individuals and another, but rather there are differences of behavior expressing differences in social relationship. Individuals conscious of their membership in certain groups are reacting in certain accepted ways to other individuals representing another group. Behavior varies according to these stereotyped conceptions of relationships. The worker, for example, behaves toward his foreman in one way, toward his first-line supervisor in another way, and toward his fellow worker in still another. People holding the rank of inspectors expect a certain kind of behavior from the operators; the operators from the inspectors. Now these relationships, as we all know from everyday experience, are finely shaded and sometimes become very complicated. When a person is in the presence of his boss alone, he acts quite differently from the way he acts when his boss's boss is also present. Likewise his boss acts toward him alone quite differently from the way he behaves when his own boss is also there. These subtle nuances of relationship are so much a part of our everyday life that they are commonplace. We take them for granted. We hardly realize the vast amount of social conditioning that has taken place in order that we can maneuver ourselves gracefully through the intricacies of these finely shaded social distinctions. We only pay attention to them when we blunder into new social situations where our past social training prevents us from making the necessary delicate interpretation of a given social signal and hence brings forth the socially wrong response.

In the factory, as in any social milieu, a process of social evaluation is constantly at work. From this process distinctions of good, bad, inferior, superior, etc., arise. This process of evaluation is carried on with simple and ready generalizations by means of which values become attached to individuals and to groups performing certain tasks and operations. It assigns to a group of individuals performing such and such a task a particular rank in the established prestige scale. Each work group becomes a carrier of social value. In industry, with its extreme diversity of occupations, there are a number of such groupings. Any noticeable similarity or difference, not only in occupation but also in age, sex, and nationality, can serve as a basis of social classification, as for example the married woman, the old-timer, the white-collared or clerical worker, the foreign element. Each of these groups too has its own value system.

Now the patterns of interaction that arise between individuals or between different groups can be graded according to the degree of intimacy involved in a relationship. Grades of intimacy or understanding can be arranged on a scale and expressed in terms of social distance. Social distance measures differences of sentiment and interest which separate individuals or groups from one another. Between the president of a company and the elevator operator, there is considerable social distance; more, for example, than between the foreman and the bench worker. Social distance is to social organization what physical distance is to physical space. However, physical and social distance do not necessarily coincide. Two people may be physically near but socially distant.

Just as each employee has a particular physical location, so he has a particular social place in the total social organization. But this place is not so rigidly fixed as in a caste system. In any factory there is considerable social mobility or movement. Movement can occur in two ways: The individual may pass from one occupation to another occupation higher up in the prestige scale. Or the prestige scale itself may change. It is obvious that these scales of value are never completely accepted by all the groups in the social environment. The shop worker does not quite see why the office worker, for example, should have shorter hours of work than he has. Or the newcomer whose efficiency on a particular job is about the same but whose hourly rate is less than that of some old-timer wonders why service should count so much. The management group, in turn, from the security of its social elevation, does not understand what all the fuss is about. Advocates of a different social scale, therefore, are constantly trying to upset the existing social equilibrium and establish the supremacy of their own scale.

Any person who has achieved a certain rank in the prestige scale regards anything, real or imaginary, which tends to alter his status adversely as something unfair or unjust. It can be seen that any move on the part of the company may alter the existing social equilibrium to which the employee has grown accustomed and by means of which his status is defined. Immediately this disruption will be expressed in sentiments of resistance to the real or imagined alterations in the social equilibrium. In the case of the complaints of the production people previously given we have a good example of this phenomenon.

THE PROBLEM OF COMMUNICATION

In the technical organization of most companies there is very little explicit recognition given to these social distinctions. The blueprint organization plans of a company show the functional relations between working units, but they do not express these distinctions of social distance movement, or equilibrium. This hierarchy of prestige values, which tends to make the work of men more important than the work of women, the work of clerks more important than the work at the bench, has no meaning for the technical organization. Nor does a blueprint plan show the primary groups, that is, those groups enjoying daily face-to-face relations. Logical lines of vertical and horizontal coordination of functions replace the actually existing patterns of interaction between people of different social places. From a technical standpoint, social place has no existence; only physical space exists. In place of all the sentiments of value residing in the social organization by means of which individuals and groups of individuals are differentiated, ordered, and integrated, there is substituted the logic of efficiency. Now it can be seen that this failure to recognize explicitly these human interrelations has certain consequences.

For example, the problem of communication is very important in the effective integration of any group or of a group of groups, of which industry is composed. Successful communication between individuals depends upon something more than a common language, a common set of words. People and groups with different experiences and social places, although having in common many of the same words, may vary widely in mental attitudes. These differences in modes of thought and ways of viewing things may make communication in some instances almost impossible. The trained expert with his precise and logical vocabulary has difficulty in communicating with the layman. The customary ways of thinking of the skilled toolmaker, for example, are quite different from those of the non-machine minded unskilled worker. They differ also from those of the engineer, the accountant, the marketing expert, the executive, or the administrator. As it is commonly expressed, people with different ways of thinking do not "get" each other.

If there is to be successful communication between the top and bottom of an industrial organization, these differences in modes of thought must be more clearly recognized. The same symbol does not necessarily have the same referent for different groups. Most symbols not only point out something, they also convey certain emotions. There is no better example than the case of the language of efficiency. The top of the organization is trying to communicate with the bottom in terms of the logical jargon and cold discriminations of the technical specialist, the engineer, the accountant, etc. The bottom of the organization, in turn, is trying to communicate with the top through its own peculiar language of social sentiments and feelings. Neither side understands the other very well. To the bottom the precise language of efficiency, instead of transmitting understanding, sometimes conveys feelings of dismay and insecurity. The bottom, in turn, instead of transmitting successfully its fears of social dislocation, conveys to the top emotional expressions of petty grievances and excessive demands.

The following situation is an example of what I mean. A company found it advisable to reduce the hourly rates of a number of long-service employees. This move was made not with the idea of reducing labor costs, but primarily with motives of "fairness and justice" in mind. It happened that the company had been left after the depression with a number of long-service people whose hourly rates were "out of line" with the grades of work they were doing. When business picked up and new employees were hired at hourly rates comparable to the grades of work to which they were assigned, and put into work groups with these longer-service people under the group payment plan, a situation to the disadvantage of the younger and newer men was created. In fairness to these new men, management felt something should be done. Clearly, the executives of the company had human values in mind when making this change. The purpose of their plan was to redistribute more equitably the total earnings of a group piecework department among its individual members. But here is the curious part of the story. When the company put in this change, it explained the move to the employees concerned in terms of the language of efficiency. The employees' response to this move was bitter and voluble. The more management tried to explain its reasons for making this change, the more resistance it met. Finally, one executive in conference with the employee representative saw what had happened. The company had always had a policy favorable to its long-service employees. With this move the long-service employees felt that the company had changed its policy with regard to them. It seemed to them that efficiency only, not service, now counted in the company. When the executive was able to reassure the employees that this move in no way had changed the basic company policy toward seniority, that long service was still valued and would be rewarded by certain considerations and privileges, the disturbance died down. The employees affected were satisfied to accept the change as long as the social values attaching to long service, which the company had upheld, had not been changed.

CONCLUSION

In conclusion, let me review briefly the points that I have made:

1. Without misunderstanding, no particular economic activity can be torn apart from its surrounding social fabric and treated as a thing in itself. In the trade activities of the natives of the Melanesian Archipelago, for example, the economic functions of trade and canoe building cannot be adequately understood apart from the background of the Kula, a set of beliefs and attitudes expressing their social organization.

2. Modern management tends to subsume the problems of group collaboration under the technical problems of production and efficiency. As

a result, collaboration is conceived of as a logical contrivance for getting people to work together by appealing primarily to their individual economic interests.

3. However, modern industry is built up of a number of small working groups. Between the individuals within these groups and between individuals of different groups, there exist patterns of behavior which are expressing differences in social relationship. Each job has its own social values and its rank in the social scale.

4. Each industrial concern has a social as well as a physical structure. Each employee not only has a physical place but he also has a social place in the factory. Any technical change on the part of management may therefore affect not only the physical but also the social location of an individual or group of employees. This fear of social dislocation is likely to be a constant threat to the social security of different individuals and groups of individuals within the industry.

5. The failure on the part of management to understand explicitly its social structure means that it often mistakes logical coordination for social integration. This confusion interferes with successful communication up and down the line as well as between different groups within the industry.

6. WORKFLOW AND HUMAN RELATIONS

From F. L. W. Richardson, Jr., and C. R. Walker, *Human Relations in an Expanding Company: A Study of the Manufacturing Departments in the Endicott Plant of the International Business Machines Corporation,* Yale Labor and Management Center, New Haven, Conn., 1948, pp. 54, 55, 60, 61, 66, 67, 69, 71–73.

INTRODUCTION

Modern employers are instinctively aware, or should be, of the close tie between good human relations and a well managed factory. Informal expressions of this awareness, too often neglected by the human relations experts, are familiar: "good industrial relations begin at the bench. . . . A smoother workflow often means better morale. . . . I don't care how high wages are, or how good the personnel department, a badly managed factory can't have good human relations."

This chapter examines, with certain qualitative and quantitative measurements, those familiar expressions of practical wisdom. More precisely, it is an examination of the ways in which the technical work process affects human relations. Such an investigation can be explored in a number of ways, one of which is, for example, through the reaction of the individual worker to his immediate job. Here, however, the approach will be to look broadly at the factory's system of workflow as a whole, to contrast the systems prevailing in 1940 and in 1947. What are the changes that have improved or worsened human relations? What connection, if any, exists between the smooth and efficient flow of work and "good" or "bad" human relations, and why?

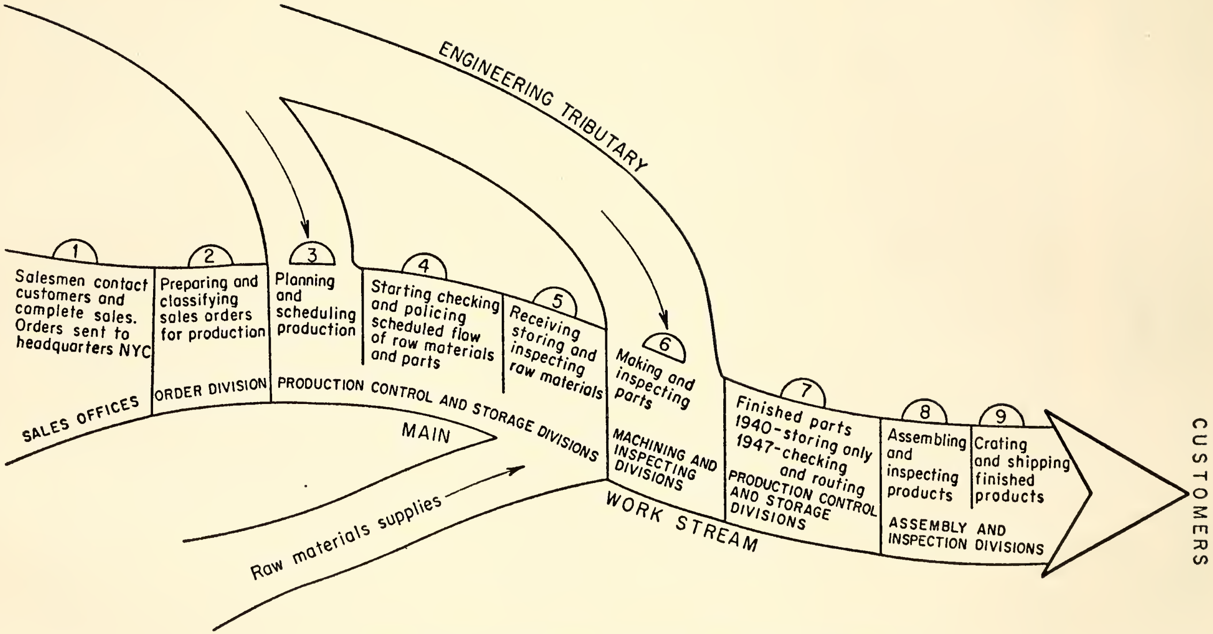
A workflow system in any factory may be compared to a river stream. The raw materials, the orders, the engineering blueprints all start, so to speak, at the headwaters of the workstream. Unfinished parts flow downstream from operator to operator, section to section, division to division, until they are assembled, packed and shipped at the stream's end. Such a concept and image has several advantages. It enables one to visualize clearly, and also to plot graphically whatever a department or an individual contributes to the workflow at the physical spot where his contribution is made—whether, for example, he is a production planner who processes the papers necessary for planning the flow of parts or a machine operator, processing the actual parts planned.

Everywhere industrial growth exhibits organization changes and changes in the work process such as new technologies, new layouts, new methods of plant "control." All of them have some effect, some of them have revolutionary effects on the plant's system of human relations. Typically, in modern industrialism, the trend is toward mass production techniques, toward continuous flow operations, toward progressive assembly lines. All of these techniques are intended to make the work flow faster or more smoothly. But what effects do they have on human relations?

An effort is made here not to generalize about such effects—there is already a large body of literature which does so—but to report in detail what one major change in workflow did to one existing pattern of human relationships. No claim is made that particular solutions to workflow problems at IBM will everywhere prove applicable. Nevertheless, the recorded experience of one company, it is hoped, will prove useful to others.

The subject of this chapter is focused on the flow of work along the main workstream with special emphasis on the material flow in the Assembly Division where between 1940 and 1947 a considerable change in workflow occurred which had important repercussions on human relations throughout the whole plant.

Layout and workflow at IBM in 1940 suited a relatively small plant producing precision and specialized products with variations and improvements constantly introduced to meet customer requirements or to simplify the manufacturing process. Essentially, the system in effect was a job shop or job lot manufacturing operation. Necessary parts were prepared in the Machining Department and stored in bins. In their flow through Machining, the pieces for a given part went from machining section to machining section without once going to central stores. However, such was not the


ENGINEERING TRIBUTARY
1
Salesmen contact customers and complete sales. Orders sent to headquarters NYC
SALES OFFICES
2
Preparing and classifying sales orders for production
ORDER DIVISION
3
Planning and scheduling production
4
Starting checking and policing scheduled flow of raw materials and parts
5
Receiving storing and inspecting raw materials
PRODUCTION CONTROL AND STORAGE DIVISIONS
6
Making and inspecting parts
MACHINING AND INSPECTING DIVISIONS
7
Finished parts 1940-storing only 1947-checking and routing
PRODUCTION CONTROL AND STORAGE DIVISIONS
8
Assembling and inspecting products
9
Crating and shipping finished products
ASSEMBLY AND INSPECTION DIVISIONS
MAIN
WORK STREAM
Raw materials supplies
CUSTOMERS

THE FLOW OF WORK— MAIN WORK STREAM

Diagram 5*a*

case in the Assembly Department. Once a part was started on its journey through Assembly it returned to central stores several times.

Each time a part or unit was returned to the central store room, it was allotted a new number, which necessitated making a record of that part's number and figuring costs for it.

As early as 1940, before the period of the Company's greatest expansion, the disadvantages of the old system had begun to outweigh its benefits. Management was well aware of the excessive costs due to multiple handling, but as long as all operations from Machining to Assembly were crowded into a single building, any drastic reorganization of workflow was difficult. In 1942, new buildings were constructed which increased available factory space. Lay-outs were reorganized and a progressive workflow introduced into the Assembly Department.

Now parts and assemblies flow downstream without returning to a central storeroom. The reader, however, must not visualize a rapidly flowing stream of parts whose assembly requires precise timing. In fact, in 1940, parts and assemblies were stored in the central store room from two to almost six months. By 1947, storage time had been cut to one month. Parts and assemblies were placed in bins in the section using them. Thus, the 1947 progressive assembly line resembled a more smoothly controlled stream whose daily flow is regulated by a system of storage dams.

In order to achieve this smooth flow of materials along the progressive assembly line, it has been essential to improve production in the paper flow sections upstream. As the assembly line required closer timing in the downstream flow of materials, better routing and scheduling was an absolute necessity.

An account by one division head of the shift from the "old" to the "new" system should help to interrelate some of the facts, as well as to show how the whole transformation appeared not to an outside observer, but to an "insider" who was subject to the internal compulsions and requirements of both systems. The account was given to the investigators by a supervisor in a strategic position in the workflow.

"I will explain the way we operated before the war. At that time we had an assembly order and the Manufacturing and Machining Departments stock-piled all the required parts. We did not build complete units until all the required parts were made. Now this is all changed, especially in my department, and we build for direct line assembly. We had been developing this during the war to cut down on inventory as stocks were in such short supply. It also will result in elimination of wasteful handling of stock.

"Before the war it was normal to carry an inventory of 200,000 coils ahead of the relay. Now we carry a much smaller inventory. On the first of January, 1947, we had only 30,000 and we were operating more smoothly and meeting all the demands of the schedule. As the cost of each coil averaged thirty-three cents, this represented a total inventory investment on this item of $66,000 as opposed to one now of around $10,000 tied up in coil inventories—a saving of over $50,000 in the inventory of this item alone.

"This new method of direct line assembly means also a closer collaboration between departments, as formerly they were all independent and billed for inventory, and now they are all interdependent.

"The manufacturing cycle has been cut from three months to less than one month, i.e., between the time a part is begun to be manufactured and the final assembly of the part into the finished machine.

"Foremen are now coached to be interested in keeping all the parts flowing to their particular section and they must know when any part they require begins to get in short supply and why. This means that they have to exert their influence to get it out. They just can't sit back and say, 'We haven't the parts and we don't know what the matter is.' The foremen have to contact the analyzer (expediter) of the Production Control Division within their particular section and he in turn tells them who the foremen are who are responsible for the particular item holding up the part. In this way they get information to explain why items are on the so-called 'hot' list, and these foremen are then prepared to tell the division head when he comes around. If a part is not being made because other parts have a higher priority, it is then up to the division heads of Assembly to go to the head of Production Control to have him decide if the priority can be changed.

"As I have said above, all this results in a closer contact between the division heads and also between the foremen. It gives us all a more direct interest in our work."

The division head stresses one point of especial interest, the connection between the smoother flow of parts and assemblies and a closer relationship between the men who attend and keep them moving. An assembly line is both a moving stream of physical objects and a relay chain of human beings who line its banks. They extend from the first operation upstream to the last one on the delta. Along this line, the men and the supervisors are obviously in some degree dependent on each other. In 1940 when IBM operated on its old job lot basis with parts moving in and out of storage day by day, horizontal relations between men in Assembly were less. Today their interdependency—in terms of the work process—is continuous and close. This point obviously impressed the department head whose comments are recorded above.

Returning to our comparison with a river's flow, all the inhabitants *down*stream now have a *direct* interest in what is happening *up*stream. There must be no blockage or log jam at the source or at any point before the flow reaches them or it may affect them disastrously. Experience had taught the division head that as stations along the flow line grew increasingly interdependent, operators and foremen became *more closely related* to one another and to what was going on upstream. More than before they resented delays and imperfections connected with parts reaching them because bad work upstream increasingly inconvenienced their own operations. "All this results," as the supervisor summarized, "in a closer contact between the foremen," and "It gives us all a more direct interest in our work."

One important effect of the new system of workflow, therefore, so far as human relations were concerned, was an increase in the number of horizontal contacts as a result of technical changes in the work process; the horizontal "bonds of organization" became stronger. Job requirements now included increased cooperative action between a worker and those next to him both on the up- and the downstream side. The same cooperation was required between foremen of contiguous sections along the flow of work. The individual was rewarded for better cooperation with fellow foremen or workers along the flow of work. Emphasis in the organizational charter on one team was given greater reality because it was implemented by increased interaction along the whole workstream.

7. HORIZONTAL AND DIAGONAL RELATIONSHIPS IN INDUSTRIAL PLANTS

From F. J. Jasinski, "Foreman Relations outside the Work Group," *Personnel*, vol. 33, pp. 130–136, September, 1956.

Traditionally, industrial organization has been vertically oriented; its emphasis is on superior-subordinate line relationships. As a result, leadership or human-relations training courses, for foremen in particular, have hitherto concentrated more or less exclusively on the supervisor's handling of his immediate subordinates.

In actual fact, technology, especially on an assembly line or any continuous fabricating process, necessitates horizontal (peer to peer) and diagonal (superior to non-subordinate or subordinate to non-superior) relationships. Yet these are rarely, if ever, explored or discussed in foreman-training sessions.

Diagonal relationships are typified by a foreman's interaction with non-subordinate hourly employees, such as maintenance men, material handlers, and inspectors. These hourly employees are assigned to a specific foreman's section; they perform certain duties which are essential to the operation of the foreman's work group. Yet, he does not stand in a traditional superior-subordinate relationship with them. Nevertheless, the immediacy of many problems makes the formal channels (to production superior, to service department superior, to service foreman, to service hourly operator) inefficient and impractical; to be effective the foreman needs to develop new and different ways of dealing with non-subordinates.

The foreman also stands in a diagonal relationship with other foremen's workers. The number of their contacts with such workers ranks fourth in frequency, exceeded only by foremen's contacts with their own regular operators, with other foremen, and with their own utility men.[1]

These horizontal and diagonal relationships are, at present, informal in nature. They are not crystallized or formalized in job descriptions or organization charts. As has been said, they are not explored or discussed in the usual foreman training programs, yet they are of crucial importance in maintaining successful operations. Some foremen have distinguished between them and have evolved, through trial and error, effective behavior patterns for each set of relationships.

The Foreman as Intermediary for His Work Group

As has been pointed out, the progressive assembly technology of an assembly line requires foremen to interact frequently with people other than their immediate subordinates. As will be seen later, they act as their work groups' intermediaries in such matters as quality control, and requests for materials and maintenance.

The minute-by-minute observations of 56 foremen studied revealed that, on the average, a foreman spent 54 per cent of his contact time with people outside his work group. Since this was an average, it follows that some foremen had more outward contacts than others. These individual scores were accordingly studied to determine whether there was any significant correlation between the number of outward contacts a foreman had and his over-all effectiveness.

[In an automobile assembly line studied by the author,] each foreman was rated on over-all effectiveness by his general foreman and his superintendent on a one-to-three scale. The ratings of the most effective and the least effective foremen were then compared with the study's observational data on total time spent in outward contacts. This comparison showed that the more effective foremen spent significantly more time with people outside their work group; the least effective spent significantly less.

Further, the most effective foremen spent a significantly greater amount of time with other foremen. Conversely, the least effective foremen were apt not to see other foremen as often.

Finally, the most effective foremen had more contacts than the least effective foremen with service and staff personnel, such as inspectors, material handlers, and other foremen's workers.

To summarize, the average foreman on an assembly line spent less time in contact with his immediate subordinates than with other people. The most effective foremen spent a significantly greater amount of time in contact with: (1) all persons other than those in his work group; (2) other foremen; and (3) service and staff personnel.

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[1] Based on an actual count taken in an automobile assembly plant.

In other words, the more time a foreman spent as his group's intermediary, the more likely he was to be considered (quite independently of this fact) an outstanding supervisor by his superiors. His success as his group's intermediary depended on his ability to establish and maintain interactions which were formally undefined.

8. ON THE JOB OBSERVATION: A NEW TOOL FOR RESEARCH

From R. H. Guest, "Of Time and the Foreman," *Personnel*, 1956, vol. 32, pp. 478–486, May, 1956.

The conditions of the supervisor's job are often such that he cannot possibly exercise the qualities of leadership expected of him by management. Before a company engages in an extensive "program" for improving the foreman's human relations abilities, management needs to take a long hard look at the operating problems beyond the foreman's control which lead to human relations frictions and limit the time he has to spend on his essential supervisory duties. By trying to improve the man before we improve the job, we are only putting the cart before the horse. . . .

For the subject of research in the present study, we chose a modern plant engaged in the final assembly of automobiles. We decided to observe in detail each of 56 production foremen for a full eight-hour day.

The Method of Observation

The observer, with the foreman's assistance, charted the geography of each section, the work stations, and the work flow. He learned the names of parts, tools and equipment, and identified key people in the service departments and the immediate work group. The observer recorded each incident in which the foreman did something. He noted the minute or the fraction of a minute when the incident began (TIME), what the incident concerned (TOPIC), what action was involved (ACTIVITY), where it happened (PLACE), with whom it took place (CONTACT), and the direction and nature of the interaction (INTERACTION).

The reactions of the foremen to their own observation reports may have certain practical implications for counseling and training. Comments most frequently heard were:

> I never knew I did so much in the course of a day.
>
> I can see where I am doing a helluva lot of things I shouldn't be doing or shouldn't have to do—and this report got me thinking about things I should be doing and don't do.
>
> My wife has a better appreciation now of what I do!

The people on top ought to see this and maybe they would learn what a foreman is really up against.

A Typical Incident Sequence

In all, we recorded 32,652 behavior incidents. Here is a sample sequence of 8 incidents.

Time	*Description*
2:15 p.m.	Checks with scheduler S. Looks at hourly report of number of cars coming through body shop.
2:16	Walks over to R (repair man) on pickup line and checks to see if earlier repair trouble was corrected.
2:17	Calls over inspection foreman to show him a hole missing in a piece. Inspection foreman acknowledges he will notify the trim department.
2:19	Tells repair man to locate the hole by eye until it comes through all right.
2:19½	Has a drink.
2:20	Walks over to station 5 and asks his utility man how many men he still has to relieve.
2:20½	Moves along the line—stations 5, 6, 7—checking visually on the quality of work.
2:21	Checks a loose nut on a fixture at station 7. Speaks with operator.

The average number of incidents per foreman for a full day (exclusive of lunch) was 583, which means that every 48 seconds of the day the foreman was doing something different. Some foremen averaged only 26 seconds per incident while others averaged close to two minutes. This difference is explained in part by the ability of some foremen to allocate their time better than others; but a high incident rate was usually due to operational circumstances beyond the foreman's control.

Obviously, these foremen had little idle time. They had to handle many pressing problems in rapid-fire order. They had to "take" constant interruption, to retain many problems in their minds simultaneously, and to juggle priorities for action.

Average Amounts of Time Spent by Foremen on Each Topic

Topic	*Per cent of time*	*Topic*	*Per cent of time*
Quality	18.2	Production schedule	5.2
Work progress	13.2	Grievances	2.0
Personnel administration	11.2	Injury, illness	1.2
Personal relations and other non-job related topics	10.2	Housekeeping	.5
Foreman performance of an operation	8.1	Work standards	.4
Tools, jigs, and fixtures	8.1	Safety	.2
Materials	8.0	Meeting	.1
Employee job performance	7.6	Miscellaneous	2.4
		Topic unknown	2.4

(Interestingly enough, the characteristics of a foreman's job—interruption, variety, discontinuity—are diametrically opposed to those of most hourly operator jobs, which are highly rationalized, repetitive, uninterrupted, and subject to the steady, unvarying rhythm of the moving conveyer. Yet foremen are usually drawn from the hourly ranks.)

Topics

The incidents were classified under 15 topics, and the observations coded accordingly. The topics and the average percentage of time spent by the foremen on each of them are shown in the accompanying table.

In itself, this table is meaningful primarily to those engaged in automobile assembly-line operations. Of general significance, however, were the extraordinary variations that were observed between different foremen and on different days, in the allocation of their time. Some spent as much as 21 per cent, or an hour and a half, on a single topic like *Materials* while others spent less than five minutes on it. Some were tied up for two hours on a tool problem while others were involved for only a few minutes. While a number of foremen did not perform any work of hourly operators, one man spent 51 per cent of his time doing nothing but manual work. As we examined the record it became obvious that an inordinate amount of time spent on any one topic measurably diminished the amount of time available for other items in the topic profile. We also discovered that the first item to suffer was *Personal relations*, generally regarded by personnel-minded people as an important function of a foreman's job.

Activities

The 13 categories included in this dimension, and the average amounts of time devoted to each, are shown in the following breakdown:

Activity	*Per cent of time*
Talks	46.6
Looks	20.9
Manipulates	9.6
Walks	6.9
Hands, Carries	5.6
Reads	2.9
Telephones	2.4
Writes	2.1
Stands	1.0
Signals	.8
Listens	.6
Shows	.4
Sits	.2
Total	100.0

As may be seen, the activity these foremen engaged in least was *Sits,* less than one minute during the entire day! Most foremen *Walked* at least four miles every day and some as much as six. Two categories, *Manipulates* and *Carries,* took up more than 70 minutes a day on the average. On the other hand, the activity *Shows,* involving some kind of operator instruction with demonstration by the foreman, took up less than two minutes of the entire day. For those who place importance on the foreman's role as an instructor, this finding may come as a surprise, but careful examination of the detailed observations revealed scores of interrupting priorities which precluded his performing this essential function.

Contacts

As the following breakdown shows, the average foreman was in face-to-face contact with some other person 57.3 per cent [1] of the time:

Contact	*Per cent of time*
Own Operators	26.4
Other Foremen	7.0
General Foreman	4.6
Department Superintendent	1.1
Other Superiors	.4
Service Personnel	
Maintenance	2.5
Inspection	2.3
Material	2.6
Work Standards	.4
Other Operators	3.8
All Others	6.2
Total Contact	57.3

This finding underscores the importance of a foreman's "social" skills on the job. Most of his contacts, however, were short and usually interrupted, often because a new emergency arose. Discontinuity and interruption, the characteristics of the foreman's contacts with others, can be traced to the compelling demand to keep the line moving and to take care of any immeditae difficulty which might upset the work flow.

The average foreman talked with many different individuals, rarely fewer than 25 and often more than 50. He dealt with a wide variety of persons in the operating and service departments and on different levels. The foreman is probably in contact with more people in the course of a day than anyone else in the management organization.

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[1] The percentage of time spent on Contacts was higher than the percentage spent on *Talks* shown in the Activity breakdown because Contacts included activities where no verbal interaction was involved.

As might be expected, foremen talked more with their own operators than with any other single group in the organization. Nevertheless, it was found that the average foreman spent *less* than five minutes per man per day. Many foremen had to spend long periods of time in contact with one or two operators to the virtual exclusion of the rest.

Curiously enough, when comparisons were made between contacts with subordinates and contacts with all others, the foreman was found to have spent less time with his own men than he did with others. Most of the leadership or human relations training we hear about focuses almost exclusively on foreman-worker relationships. What about relationships with inspectors, maintenance personnel, other foremen? And what about the boss? This study showed more contact between a foreman and his general foreman than with any other individual.

As regards the last two dimensions of behavior—place and interaction—it was found that foremen spent 14 per cent of their time *outside* their own sections, and that 60.3 per cent of a foreman's contacts were initiated by himself and 37.7 per cent by someone else.

Uses of the Findings

The most important use to which the information can be put is to bring home to operating people the fact that operational bottlenecks and difficulties not only hurt production as such, but they also affect the foreman's ability to plan ahead and avoid future difficulties.

Foremen are always getting caught in this familiar vicious circle. Material inspection, say, has failed to spot some faulty pieces. Something goes wrong at a welding operation. The general foreman is on the foreman's neck to "get it straightened out, or else!" The foreman drops everything to spend time on this one item. He cannot pay attention to the man he was breaking in on a new job. He cannot check on the stock bin which the stock man forgot to replenish. He meant to warn an operator about a safety condition. He knew another man was down in the dumps about a personal problem. By the time he has cleared up the original trouble and satisfied the boss, something else has blown up and the general foreman is roaring down the aisle again.

In some instances, management was able to use the observations to spot specific conditions requiring correction. For example, it was discovered that nine foremen, all in one department, averaged over two hours apiece doing manual labor. When a foreman has to perform manual work for long periods of time he is obviously not supervising. In this instance, management was not wholly aware of the condition. The observations revealed the source of the trouble—a serious shortage of manpower. On a moving assembly line, every operation must be manned all the time by qualified operators. In this case, the effort to reduce labor costs to a minimum had gone too far and adequate replacements were not available to cover for absentees. So these foremen ended up by spending much of their time doing work which drastically cut in on their other duties. As it turned out, management now fully recognizes the problem and is taking measures to correct it.

Numerous other practical illustrations could be cited, [but] what clearly emerges from these detailed observations of the foreman's job is that there is considerable difference between what a foreman *should* do and what he *can* do. A foreman who has to jump from one operating emergency to another every 45 seconds has neither the time nor the inclination to practice the fine precepts he is exposed to in human relations training programs. Indeed, such training may only serve to compound his own frustrations.

What is called for, first, is a reduction of built-in frictions caused by operating emergencies—potential sources of conflict which so often are caused by conditions beyond the foreman's control. When operating conditions give foremen that treasured commodity, *Time*, then leadership and human relations training can begin to pay off.

9. WORK GROUPS ON THE ASSEMBLY LINE

From C. R. Walker et al., *The Foreman on the Assembly Line*, Harvard University Press, Cambridge, Mass., 1956, pp. 127–141.

Nature and Importance of Groups on the Assembly Line

The technology of the assembly-line environment [is such as] to suggest that the workers under any given foreman are not the same as the close-knit groups or crews and teams common to many industries, where all members have separate but strictly interdependent functions, and tend to think of themselves as a "baseball nine" or a "football eleven." On the assembly line, men do work that is rarely related, team-wise or in a strict functional sense, to what other members of the group do. For this reason in our early study of assembly lines, our first impression was that technology had eliminated the work group altogether, leaving merely a tenuous relationship between individuals and the foremen.

But this is not true, whatever the logic of engineering. Every segment of the line under a foreman is an actual or potential work group or team.

Social scientists, in discussing groups, use the term cohesiveness rather than strength. This, as commonly understood, means a measure of the durability of the group. We are interested in the durability of a group, but more precisely we are interested in the resultant power of its members to think and act as a single unit and to fulfill their common objectives by so doing.

Before examining why groups vary in cohesiveness, we need to state two assumptions which should be kept in mind throughout this discussion:

The first is that there tends to be a positive correlation between the amount of interaction among members and the cohesiveness or strength of the group. In other words, the more frequently people in a group talk with one another—or otherwise interact—the stronger the group.[1]

A second assumption is that a strong and cohesive group with the foreman as its leading member is desirable. Personal satisfactions of its members are increased. Frictions are reduced. A sense of purpose develops which can lead to improved efficiency and quality. These assumptions can be justified, we believe, not only by our own observations and research at Plant X and elsewhere, but also by reference to the large volume of recent social-science research into the nature and functions of groups in industry and elsewhere.

One fundamental reason that a feeling of belonging to a cohesive group of men at work increases the average worker's satisfaction with his job and with the company may well be that without a group to identify with, there is in most large organizations a feeling of anonymity which most people dislike. Certainly this has been true for the automobile assembly workers interviewed in our studies. In both plants surveyed, considerable bitterness was expressed against what appeared to the workers as "impersonal treatment" by the company. A surprising number felt that "the company isn't interested in people," or "you're just a number as far as they're concerned." [2] This feeling of anonymity, caused at least in part by the relatively impersonal nature of the work itself on most asembly-line jobs, can create or accentuate problems of morale, absenteeism, turnover, and quality.

Our evidence is that the successful foreman at Plant X intuitively recognized the importance for the average worker of belonging to a group, and purposely related himself not only to each individual but to his group of men as a whole. This constituted one method, and an important one, by which the foreman counteracted the pressure and impersonality of the work environment.

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[1] There are obvious exceptions to this statement and yet it remains a useful generalization. One exception is this: If the members markedly disagree on the group's goals, increasing interaction may increase their disagreement and so reduce the group's cohesiveness. For a discussion of this and related points, see W. F. Whyte, "Leadership and Group Participation," New York State School of Industrial and Labor Relations, Bulletin 24, Ithaca, N.Y., May, 1953, pp. 28–30. See G. G. Homans, *The Human Group*, Harcourt, Brace & World, Inc., New York, 1950, pp. 110–117, 243, 444. See also the "Note" by Paula Brown and Robert Brown, and Homans' reply, in *American Sociological Review*, vol. 20, no. 1, pp. 83–86, Feb., 1955.

[2] See C. R. Walker and R. H. Guest, *The Man on the Assembly Line*, Harvard University Press, Cambridge, Mass., 1952, pp. 135–140. These attitudes were still more strongly expressed by the longer-service men in the second assembly plant studied.

We are now ready to look at the factors which weaken, and those which strengthen, work groups on the assembly line.

Factors That Tend to Weaken Groups

These factors are important because it is only by counteracting them that a foreman derives the advantages of a cohesive work team, and significantly, nearly all of them appear as barriers to interaction between men on the assembly line.

The first and most obvious barrier is noise. In many of the sections along the line, *verbal* interaction, at least, is difficult or impossible. Even where noise does not inhibit interaction, the average worker has to pay close attention to the line, which is always moving in front of him, if he isn't to "go into the hole." He can seldom or never stop even for a moment to chat with his neighbor. And unlike some assembly jobs in other industries, the work on an automobile assembly line often requires a degree of "surface mental attention"[3] which makes it difficult or impossible to work and talk at the same time, except for the occasional exchange of a few words—for example, when there is a gap in the line. Also, except when he takes personal relief, the average worker must remain at his station throughout the work day, which sharply limits the number of men with whom interaction is possible.

A more important and basic limiting factor is that the technical nature of the work of an assembly line neither suggests nor compels interaction. Interaction connected with the work, such as interchange of tools, signals, reciprocal or team activity, is not usually necessary. In other words, there are fewer absolute *functional* requirements for interaction between men in an assembly plant than in many other industries.

Group cohesiveness is also limited by the fact, characteristic as far as we know only of assembly lines, that every group under a foreman is, so to speak, blurred at both ends so far as interaction goes. To illustrate: imagine a moving line, let us say, a hundred and fifty feet long with three groups of workers each occupying fifty feet of the line. The men are on each side of the line, and let us say each group of twenty men has ten on one side and ten on the other. Because of the noise and close attention to work, interactions can only occur with men who are near each other. Thus, an individual worker is likely to interact, in the course of a day or a month, with only a fraction of his own work group, and then only briefly and infrequently. And the workers at either end of the section interact as frequently, because of proximity, with members of the next group as they do with their own. Because of this interaction pattern, the boundaries between groups are blurred, and all the individuals in the group with which a worker tends to interact do not necessarily come under the same foreman.

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[3] See *The Man on the Assembly Line*, pp. 12–13.

Not only is the cohesiveness of the men in a foreman's section limited by this overlapping at the edges; equally important are changes in the composition of work groups caused by fluctuations in production, turnover, and absenteeism. Even when interaction among members of a potential group is frequent, it takes time for cohesiveness to develop. Whenever schedules fluctuate sharply up or down, the composition and size of the groups change, and often individual members report to different foremen. In the same way turnover and absenteeism disrupt the composition of a group, and make it more difficult for foremen to develop that feeling of belonging and loyalty which comes from stability of membership.

Characteristics of Strong Groups

In spite of these inhibiting factors, some foremen *were* able to build with and between their men a strong sense of belonging to a group. Under the foreman's leadership, members of that group helped each other out in performing what they thought were their common objectives in getting the work done. How was this possible? How did these foremen manage to overcome the various handicaps to group formation discussed above?

The evidence suggests that in those sections in which the foremen had been able to develop a sense of group or team spirit:

1. Interactions were more frequently reciprocal than unilateral between foreman and workers;
2. Key operators served as channels of communications;
3. Interactions between operators were functional or problem-solving. Some self-determination and informal job rotation was practiced.

When there were more reciprocal than unilateral interactions between the foreman and his men, that meant as a rule that when the foreman talked with a worker he was asking a question and listening to a response, rather than merely making a demand or transmitting an order. It was natural for such a foreman to delegate a certain amount of informal responsibility to his utility men or other key operators, so that there was more frequent interaction between the foreman and his other men. Thus, the group structure in such instances did not simply comprise two levels of communication, the level of the formal leader (the foreman), and the level of all his subordinates. There was in addition a third, informal level, consisting of one or more utility or other key men.

A foreman who believed that his section operated more effectively when greater responsibility was distributed to his key operators practiced the same philosophy when he also allowed and encouraged his regular operators to take some of the responsibility for ensuring that good work was done in the section. Thus this meant that there was more interaction between operators concerning the work than in other sections. Without waiting for the foreman or inspectors to point out trouble, the operators themselves kept each other posted about actual or potential trouble encountered in the section, and, furthermore, advised one another as to steps which should be taken to correct the difficulty.

This kind of interaction among the men also reflected a certain amount of group self-determination allowed by some of the foremen. Though they maintained full responsibility for the end results, some foremen allowed the operators to determine how the work load was to be distributed among the group. At times the group, with the foreman's guidance, established informal systems of job rotation, and so, over a period of time, the average man in the group came to interact with most, if not all, of the members of the section. He was not tied to one location or limited in his interactions to those immediately adjacent to his work station. Our previous studies indicated that informal job rotation among hourly workers increased their satisfaction.[4]

Conclusions

It is obvious that the more successful foremen, in whose sections these patterns of interaction were observed, had particular ways of perceiving their role. Most important were their willingness and ability to think of themselves as the leaders (and therefore members) of a group of men, and to delegate to them a greater amount of initiative and responsibility than was strictly called for in the formal organizational structure. A successful foreman not only pays attention to his relations with his men *as individuals*, but also *as a group*, with a certain group attitude and structure. He bases his approach to them upon the assumption that they are willing and able to help each other and himself out by doing the work well. Perhaps the most important characteristic of a good foreman, especially in helping him to strengthen group cohesiveness and loyalty among his men, is this readiness to think well of his men, to make a partial identification with the men's feelings and viewpoints—an identification not as a rule shared by upper management.

In conclusion, two further suggestions for increasing group strength and cohesiveness may be emphasized. The first is through periodic meetings held by the foremen with their men. Such meetings, either weekly or once a month, tend to develop effective group relations and are becoming increasingly prevalent in American industry. Their special importance on the assembly line is accentuated by the limits to interaction imposed by technology. The foreman who regularly meets with his men increases quality-consciousness, gains valuable production suggestions, and increases group morale.

A more fundamental requirement for realizing the potential benefits of greater group cohesiveness would be a basic re-design of assembly jobs themselves with a view toward satisfying and tapping more fully the plant's human resources. When engineers take fully into account individual and group dynamics in the design of jobs and processes, more enthusiasm and initiative will be released at work than is possible within the present limits of mass-production technology.

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[4] See *The Man on the Assembly Line*, pp. 148–151.

[The above selection, which is taken from *The Foreman on the Assembly Line,* weights rather heavily the role of the foreman in the work group. Many work groups in industry, especially when they are both traditional and functional as in the steel industry, tend to be semi-independent entities, far less dependent for their usefulness and strength on the attitudes of supervision than are the weaker groups described in this selection.]

10. WORK GROUPS IN A SEMI-AUTOMATIC STEEL MILL

From C. R. Walker, "Life in the Automatic Factory," *Harvard Business Review,* vol. 36, pp. 111–119, January–February, 1958.

NEW WORLD

After World War II a large American steel corporation decided to install one or more automatic seamless pipe mills "to make a better product more cheaply" and to solve the typical manufacturing problem of "sharper competition in an era of rising costs." They solved the problem—and in the process created, almost without knowing it, a wholly new working world for the men and supervisors affected. What happened in this mill is a story that, in many respects, may be happening over and over again in American industry.

The work environment of this new mill is quite unlike the old, where physical labor and manual control of tool and product prevailed. The complex system of conveyers and moving tables which now take the product through its complete work-flow cycle is wholly automatic, characterized by electric eyes, timing devices, limit switches, rotary controls, and so forth. The top operators are partly technicians, partly coordinators of operations. The furnace discharger has a mixed job, half of it consisting of watching truly automatic equipment, the other half of manually operating levers and buttons. Jobs like the bar inserter's and the stripper's are wholly automatic, performed by machinery without the operator's lifting a hand; but they must watch and, if anything goes wrong, intervene with manual correction.

In the long road toward the wholly automatic factory there will be many jobs like these. Our first vivid impression in talking to the participants in the technological revolution which had produced this automatic mill was that workers and management had not simply gone from one pipe mill to another, but had left one epoch in industrial time and entered a new one. The novelties of their experiences in a new factory world impressed them and impressed us, the researchers. Here are typical comments from hourly workers:

> I'd rather have to work hard for eight hours than to do nothing physical but have to be tense for eight hours, the way I do now.
>
> On my old job . . . my muscles got tired. I went home and rested a bit and my muscles were no longer tired. On this new automatic mill, your muscles don't get tired, but you keep on thinking, even when you go home.

The fact that technology is replacing muscular fatigue with increased tension or mental effort is one of the most striking parts of the story—but only one part. In many other ways the unique demands on the human personality imposed by automation are affecting the working lives of both manager and worker in the modern factory.

NEW WORK COMMUNITY

But what about the impact of technology on the range of *human relationships?* Individuals function not just as individuals but as members of social groups. Does automation tend to destroy or create a more cohesive work community within the mill with a sense of common interest between its members?

Persons unfamiliar with mills and factories—farmers or professors, for example—often remark upon visiting them that they seem like another world. This is particularly true if, as in the steel industry, both tradition and technology have strongly and uniquely molded the ways men think and act when at work. The newly hired employee, the "green hand," is gradually initiated into what amounts to a miniature society. There he finds himself in a strange environment that assaults his senses with unusual sounds and smells and often with different "weather conditions" such as sudden drafts of heat, cold, or humidity. He discovers that the society of which he only gradually becomes a part has of course a formal government of its own—the rules which management and the union have laid down—but that it also differs from or parallels the world outside in social classes, folklore, ritual, and traditions.

Under the process in the old mills a very real "miniature society" had grown up, and in important ways the technological revolution described in this case history shattered it. But a new society or work community was born immediately, though for a long time it developed slowly. As the old society was strongly molded by the *discontinuous* process of making pipe, so was the new one molded by the *continuous* process and strongly influenced by the characteristics of new high-speed automatic equipment.

Group Cohesiveness

It was clear from our study that the advent of automatic equipment neither destroyed nor weakened primary work groups as represented by the three hot mill crews. Their internal structure was transformed, but as social units within a larger mill society they remained cohesive and strong. Most members of the mill crews had made or were likely in the future to make work careers out of pipe making. This was a life investment, in other words, and as they put it: "We actually spend more time together than with our own family." In fact, the crew members spent more time with the automatic machines than with any living or nonliving object in their lives (including their automobiles)!

In the seamless pipe mill the forces for social and functional unity were clearly triumphing toward the end of the period of our study. By that time, for example, all or nearly all production and nonproduction workers were sharing in an incentive based on the output of the entire mill. This condition corresponded to the men's wishes and to the nature of the productive process. Finally, although there were many ups and downs in the quantity and quality of worker-supervisor relations, the potential for functional—and friendly—relationships was being realized toward the end of our study.

Joint Problem Solving

The most striking evidence of the desire on the part of the workers to become integrated into a bona fide work community was their continuing eagerness to share in the solution of production problems.

For instance, we asked: "If you were boss, what would you do to make this a better mill?" The two most important answers as measured by frequency and emotion were (a) "better relations with supervision" and (b) "the chance to help solve mill problems." It was obvious that the two ideas were connected in the men's thinking. Moreover, they were talking about something much more intimate, meaningful, and continuous than a "suggestion box." In effect they were saying:

> Each one of us knows more about his own job than anyone else—including management. Besides being individuals, we are members of a closely knit work team, which also tells us important things about this mill and its product. We work at making seamless pipe eight hours a day and expect to do so the rest of our working lives. For these reasons the mill as a work community is as much our mill as management's. Why shouldn't we be asked, then, to contribute our brains and our imagination—as well as our muscle—to the solution of mill problems?

As the widespread success of suggestion systems and (at a more advanced stage of participation) of the Scanlon plans testifies, desire to participate in solving production problems and improving work processes is not confined to automated manufacturing plants. But it is especially strong here, for three reasons:

1. The ambition clearly accords with the real and practical needs of the plant, especially during the break-in period.
2. It springs from deep psychological needs.
3. The men's desire to join actively in applying their brains to technical and production problems clearly fits in with the technology.

In short, automation accents the *interdependence* of all the elements in a plant—men, machinery, maintenance, and management—in achieving uninterrupted production: and interdependence implies *participation*.

11. GENERAL COMMENTS ON SPECIALIZATION

From James C. Worthy, "Organizational Structure and Employee Morale," *American Sociological Review*, vol. 15, no. 2, pp. 174–178, April, 1950.

We have had 12 years of experience in the formal study of employe morale. During that period our surveys have covered over 100,000 employees, working in several hundred different company units both in Sears, Roebuck proper and in a number of other organizations as well. Types of employes covered include sales and clerical personnel, manual and professional workers, supervisory employes, and executives. The size of units surveyed has ranged from fewer than 25 employes to more than 10,000. Many different types of units have been surveyed, including retail stores, mail order plants, factories, warehouses, and offices. The geographical distribution of employes covered would correspond rather well with the geographical distribution of the U.S. population. By the same token, the communities in which units surveyed have been located cover practically the full range of sociological and cultural categories to be found in this country, except the small town and the rural. . . .

The results of our research suggest that over-complexity of organizational structure is one of the most important and fundamental causes of poor management-employe relationships in our modern economic system, and that until this problem is faced and corrected no substantial improvement in those relationships is likely to be possible.

In viewing many business enterprises, one cannot but be impressed by the number of different departments and sub-departments into which they are divided, and the extent to which the activities of both individuals and groups have been highly specialized. In a very large number of cases, employes perform only elementary, routine functions because jobs have been broken down "scientifically" into their most elementary components. The resulting specialization undoubtedly has certain advantages, such as requiring less skilled people, shorter training time, etc. In many cases, however, the process has been carried to such extremes that jobs have little inherent interest or challenge; operations have been reduced to the simplest possible repetitive level and the worker makes nothing he can identify as a product of his own skill.

One has the feeling of division of labor having gone wild, far beyond any degree necessary for efficient production. Peter F. Drucker, in a penetrating analysis, has pointed out that over-specialization is not an inevitable consequence of mass production and that, "The traditional assembly line is simply a piece of poor engineering judged by the standards of human relations, as well as those of productive efficiency and output." [1]

The evidence of the studies conducted in our own company strongly support this conclusion, for we have found that where jobs are broken down too finely we are more likely to have both low output and low morale. Conversely, the most sustained efforts are exerted by those groups of employes who perform the more complete sets of tasks (e.g., salesmen, supervisors, master mechanics, etc.), and these likewise exhibit the highest levels of morale and esprit de corps.

The sharp trend toward over-specialization in our economy has not been limited, of course, to individual jobs. Just as particular activities have been broken down into their simplest possible components and each component assigned to a different person, so many *operations* (often after having been highly "simplified") have been separated out of the broader complex of activities of which they are a part and set up as specialized and semi-independent organizational entities. While over-specialization of individual jobs is serious enough, this over-specialization of the functions of entire departments and sub-departments has even more far-reaching consequences.

For one thing, it brings together in one place large numbers of employes on the same job level (and that level is likely to be fairly low where there has been any considerable over-specialization of individual jobs). This is another way of saying that the size of the administrative unit has been greatly expanded. Let us suppose an organization which performs three essential functions, A, B, and C. Let us suppose further that the volume of output requires three units of each function. Under these circumstances the organization could be set up in either of two ways:

1. It could be set up in three divisions, each function (A, B, and C)

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[1] Peter F. Drucker, "The Way to Industrial Peace," *Harper's Magazine*, November, 1946.

being represented in each division and each division, therefore, being a relatively independent administrative entity.

2. On the other hand, the organization could be set up in three *functional* divsions, one division having all three A units, another all three B units, and the third all three C units. In this case, none of the three divisions has any independence; each can operate only in closest coordination with the other two. Under the first alternative, there are really three administrative units; under the second only one, and that, by definition. three times as large.

This second type of arrangement is typical of much modern organization practice, both in industry and government. It is assumed that this separation and specialization of activities will permit better supervision, make possible smoother scheduling, and generally improve efficiency. There may be a certain spurious efficiency in this kind of organization but it is likely to have many off-setting liabilities.

One of the most serious of these liabilities is the fact that it so greatly expands the size of the administrative unit. Much of industry's present vast scale of operation is required not so much by economic or technical factors as by an unhappy and unnecessary principle of organization. The experience of many companies, of which my own is one, demonstrates that it is entirely possible to have many of the economic and technical advantages of large size without sacrificing too many of the essential human advantages of small size.

A further liability of over-functionalization is the fact that, from the standpoint of the individual employe, it tends to destroy the meaning of the job. He and those around him are working at highly specialized tasks which have meaning to management because they are a necessary part of a total process. But the worker cannot see that total process; he sees only the small and uninteresting part to which he and his fellows are assigned. In a real sense, the job loses its meaning for the worker—the meaning, that is, in all terms except the pay envelope.

Thus a very large number of employes in American industry today have been deprived of the sense of performing interesting, significant work. In consequence, they have little feeling of responsibility for the tasks to which they are assigned. Management in its efforts to maintain production in face of the resulting apathy is likely to resort to increasing supervisory pressure, but this procedure only creates more resistance on the part of employes. Sometimes the resistance is only passive, in the sense that employes fail to respond to the pressure or find means of avoiding it. Under certain circumstances, however, it can take more active form and lead to the creation of resistance groups in which employes band together (commonly through union organization) to exert a corresponding pressure against supervision and management.

Over-functionalization thus requires close and constant supervision at the work level to maintain production. Furthermore, the supervisors themselves must be closely supervised and controlled to assure the necessary degree of coordination between the many different units into which the organization has been sub-divided. In a simpler type of organization structure, coordination can usually be achieved on a fairly informal basis because there are fewer artificial barriers in the form of departmental separations and lines of authority.

Where the work of the organization is broken down into so many functional divisions, however, cooperation can no longer be achieved spontaneously. After all, each functional unit was set up as a distinct entity in order that it might achieve a more efficient system. Each unit, therefore, tends to operate primarily in terms of its own systems rather than in terms of the needs of the other departments with which it must cooperate. Each unit becomes jealous of its own prerogatives and finds ways to protect itself against the pressure or encroachments of others. Conflict develops on the employe as well as the supervisory level, thus forcing an extra load on higher levels of management who must be constantly reconciling differences.

In order to achieve the necessary degree of coordination and cooperation between administratively separated functions, management is thus forced not only to build up an elaborate hierarchy of many supervisory levels, but to institute a wide variety of formal controls. Unfortunately, these controls are themselves often a source of conflict, because the individual supervisor or manager is under strong compulsion to operate in such a manner as to make a good showing in terms of the particular set of controls to which he is subject, and often he can do so only at the expense of impairing the service he is expected to render to other departments. This conflict is particularly acute when two closely related functions report up two different administrative lines and operate under two different systems of standards and controls.

The management of organizations which have been over-functionalized to the extent characteristic of much of modern business imposes a severe burden on the top administrative staff. Functions and activities have been so subdivided and specialized that no individual unit can operate except in closest coordination with others, and the system is often so complex that this coordination cannot take place spontaneously. If it is to occur at all, it must occur on the basis of specific administrative action from the top, which requires the development of a specialized staff to assist the top administrator.

This growth of staff complicates the situation still further, because an inevitable consequence is the elaboration of formal controls of various kinds to permit the staff to perform the functions and exercise the responsibilities which have been delegated to it or which it gradually assumes in an effort to strengthen its own position or extend its own authority. The result is a gradual undermining of the line organization for the benefit of the staff, an impairment of flexibility and adaptability, and a weakening of the effectiveness of the entire organization.

An objective appraisal suggests that to too large an extent work processes have been analyzed from a strictly "rational" or mechanical point of view with too little attention to the human factors involved. As a result, functions have been separated out of their context and set up as semi-independent activities. Necessary collaboration and cooperation between the units thus artificially separated becomes possible only through an elaborate system of controls and a complicated administrative hierarchy. Under these circumstances, management necessarily becomes strongly centralized, despite the frequently expressed concern of business leaders over the need for greater delegation of authority and responsibility. Too often, this is simply impossible because the nature of the organization structure makes effective decentralization impossible. For much the same reason, such organizations often require from their top administrators a high degree of driving pressure to hold the system together and make it operate with a reasonable degree of efficiency.

Where this is the case, executives and supervisors down the line quite understandably tend to pattern their own methods after those of their superiors. In many cases the copying may be done unskillfully and in such a way as to exaggerate the worst features of the pressure methods. As a result, supervisory methods at the middle and lower levels of over-functionalized organizations are often crude and inept.

Furthermore, the degree of pressure often required from the top is likely to create an atmosphere of anxiety and apprehension within the executive and supervisory group. This atmosphere tends to amplify the severity of pressure as it moves downward in the organization, so that even a moderate amount of pressure at the top is often greatly magnified by the time it reaches the lower levels. Attitudes of mind characterized by fear and apprehension are not particularly conducive to real skill in managing and leading subordinates. Above all, poor supervisory techniques at the lower levels of an organization generally reflect the experience and type of supervision to which the supervisors themselves have been subjected over the years and which they have come to accept as normal and expected behavior.

The significant point in all this, however, is that the over-complex, over-functionalized organization structure is likely to require the driver type of leader; the over-use of pressure as a tool of supervision is thus related primarily to the character of the structure and only secondarily to the character of the individual at the head of it. (On the other hand, it is recognized that the personality of the top man may have a great deal to do with the kind of organization structure he sets up. This entire problem of the reciprocal relationships between structure and personality should be studied carefully.)

SYSTEMS COMPARED

The most striking feature of the over-elaborate type of organization structure is its lack of integration, a deficiency which can be only partially and very unsatisfactorily overcome by driving pressure from the top. Our studies suggest that this type of structure is not only bad human relations but equally unsound from a standpoint of productive efficiency. Our studies also suggest that alternative systems of organization are conceivable and eminently practical.

For one thing, we seriously question the necessity for much of our present high degree of over-specialization and over-functionalization. The so-called "scientific management movement" which has given such impetus in this direction is based to a considerable extent on an extremely inadequate conception of human motivation and social organization. It has tended to approach the problems of management from an almost purely mechanistic point of view and has tried to organize human efforts in much the same way an engineer might design a machine. Much of our present over-specialization is based on this type of thinking.

However, the experience of a number of companies indicates that individual jobs and departmental functions need not be broken down to this degree in order to achieve productive efficiency. Quite the contrary; their experience has been that both efficiency and morale are best served by keeping specialization to a minimum. The experience of these companies likewise indicates that organization structures and administrative hierarchies can be vastly simplified, thus making possible a far higher degree of decentralization of authority and responsibility.

In the course of our survey work we have had an opportunity to study a fairly wide variety of organization structures. We have been struck by the sharp contrasts between otherwise comparable units which differ mainly in the complexity of their organizational structure and in the degree to which authority and responsibility are effectively decentralized to those farther down the line. A review of some of these contrasts may be instructive.

In the more elaborate and complex organizations, the individual supervisor or executive is subject to constant control and direction and has little opportunity to develop the qualities of initiative and self-reliance. In systems characterized by extensive management decentralization, primary reliance is placed on the personal initiative and capacity of the people in the organization. There is usually a conspicuous lack of detailed supervision and of formal controls, and executives and supervisors (and to a large extent rank and file employes) enjoy considerable freedom in the way they accomplish their jobs.

They are judged primarily by their results, not on the details of the way they get those results. This concentration on end-results rather than on system and controls, together with management's alertness to recognize and reward good results, develops initiative and self-reliance and generates a far more powerful driving force than could ever be imposed from the top down. This pattern of administration not only gets today's job done better but permits the individual to grow and develop in a way that is impossible in more centralized systems. Furthermore, it contributes strongly to morale because employes work in an atmosphere of relative freedom from oppressive supervision and have a sense of individual importance and personal responsibility which other types of arrangements often deny them

A number of highly successful organizations have not only paid little heed but have gone directly counter to one of the favorite tenets of modern management theory, the so-called "span of control," which holds that the number of subordinate executives or supervisors reporting to a single individual should be severely limited to enable that individual to exercise the detailed direction and control which is generally considered necessary. On the contrary, these organizations often deliberately give each key executive so many subordinates that it is impossible for him to exercise too close supervision over their activities.

In this type of organization structure, the individual executive is thrown largely on his own to sink or swim on the basis of his own ability and capacity. He cannot rely to more than a limited extent on those above him, and these superiors, by the same token, cannot too severely restrict, through detailed supervision and control their subordinates' growth and development.

Not all individuals can function effectively in this type of set-up. It requires a very large measure of self-confidence and personal capacity. The system tends to weed out those who lack these qualities in adequate degree. Those who are able to adapt to this type of organization, however, are likely to be not only better executives but also the type of people who can build and maintain teamwork and cooperation and a high level of employe morale, not so much because they consciously attempt to do so but because these results are a natural by-product of their ways of operating and a reflection of their own personalities.

On the other hand, in organizations characterized by many levels of supervision and elaborate systems of controls, the individual not only has little opportunity to develop the capacities of self-reliance and initiative but the system frequently weeds out those who do. Furthermore, those who survive in this type of organization are often likely, by virtue of the very qualities which enabled them to survive, to have personalities and ways of operating which do not make for greatest skill in building employe teamwork and cooperation.

An organization with few layers of supervision and a minimum of formal controls places a premium on ability to stimulate and lead. The driver type of executive, who functions through maintaining constant pressure and whose chief sanction is fear cannot operate as effectively in such an organization. In the more simple types of organization structures, where management has been effectively decentralized, an executive accomplishes results and moves to higher levels of responsibility chiefly to the extent that he is able to secure the willing, enthusiastic support of his colleagues and subordinates; he does not have the "tools" (with which a more centralized system would to some extent provide him) to accomplish the result in any other manner. The outcome is not only a higher level of accomplishment but, at the same time, a more satisfying type of supervision and a higher level of employe morale.

CONCLUSION

Our studies have shown that employe morale and operating efficiency are closely related to the degree the organization is integrated. Integration is not necessarily achieved, however, when the organization meets the requirements of machine-logic. As a matter of fact, what may appear to be logical from a purely technical standpoint may run directly counter to the personal and social demands of employes. We have seen a number of organizations which have a logical technology, division of labor, and hierarchy of control but which are badly disorganized from the standpoint of the actual working relationships of the people involved. Such organizations are well-integrated only on paper. In actual fact, they are irritating and frustrating from the standpoint of employes and inefficient, troublesome, and costly from the standpoint of management.

12. SCIENTISTS, ENGINEERS, AND INDUSTRIAL ORGANIZATION

From Louis B. Barnes, *Organizational Systems and Engineering Groups,* Harvard Business School, Boston, 1960.

AN INTRODUCTION TO THIS STUDY

Man, we are told, has entered what was once regarded as a science fiction era of technology. News media inform us daily of the launchings of new rockets, the wonders of new drugs, the intricacies of new products, the total destructiveness of new weapons. For purposes of survival, destruction, enrichment, and exploration, man has more consciously than ever before turned his attention to the wonders and powers of science.

This focus on science has been accompanied by an equally strong focus on those who work in science and engineering. . . .

MANAGEMENT AND THE ERA OF NEW TECHNOLOGIES

To begin with, industry has had to face the enormous day-to-day task of adaptation to new technologies. A generation ago, the most sophisticated engineer in many companies tended either a heating system or a stop watch. Today, many of these same companies support impressive research and development activities. Scientists and engineers are found both in the factory and in the laboratory. In addition, growing numbers of these same professional employees each year assume positions of high management responsibility.

Nevertheless, the age-old gap between the manager and the scientist-engineer continues to exist. Management's feelings are summarized by the executive who said: "I ask for a Yes or No answer and I get back a 40-page report." [1] On the other side, a University of Chicago survey points up the chronic frustration and dissatisfaction of scientists and engineers in industry. Professional employees were found to be only slightly more satisfied than factory production workers and less satisfied than foremen, salesmen, skilled workers, or management.[2]

In a sense, management is seated on top of a technological powder keg. For competitive reasons, management must actively encourage technological change and improvement. Yet day-to-day administrative pressures often prevent management from being well qualified to judge the potential of new technological developments. Within such situations, the professional employee almost inevitably values his own knowledge and abilities more highly than he does management's "practical" experience. The engineer going into management is faced with a similar problem. The more his work takes him toward management activities, the more obsolete become his technical knowledge and judgment.

Consequently, the scientist-engineer in industry often assumes the paradoxical position of looking down upon his superiors in higher management. Scientist-engineers see management as anti-intellectual and motivated by money alone. Management pictures professional employees as narrow, impractical specialists. A recent survey conducted by Opinion Research Corporation helps to show the depth and strength of these stereotyped impressions. Of 622 engineers and scientists interviewed in six major companies:

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[1] *Business Week*, "The New World of Research," May 28, 1955.

[2] D. G. Moore and R. Renck, "The Professional Employee in Industry," *Journal of Business*, January, 1955.

1. Seventy-two per cent thought management misused the talents of scientists and engineers.
2. Eighty per cent said they were underpaid compared with other groups.
3. Most felt that management representatives got an unfair share of company and community recognition.
4. Seventy-six per cent thought management tried to manipulate people for their own purposes.
5. Over seventy per cent felt that executives tended to oversimplify problems while concerning themselves mostly with short-range goals.

Not surprisingly, the same survey showed that scientists and engineers wanted less pressure from management, greater freedom, and more flexible work schedules. Although the 105 executives interviewed seemed well aware of these complaints and desires, they believed that industry's competitive nature prevented their serious consideration. The interviewed executives felt that such freedoms belonged in academic institutions, not in competitive industry.[3]

Here, then, is the crux of industry's reluctance to utilize the scientist-engineer as he wants to be utilized. It isn't good business. It would be competitive suicide, impractical and uncontrollable. Management's logic is based on the theory of the taut ship. If a business enterprise becomes sloppy with loose controls, then productivity and profits suffer. Scientists and engineers must put away their most cherished ivory tower dreams when they leave academia. Industry has its rewards, but it also exacts payments from the professional employee; i.e., management must stay in control of the taut ship. Relaxations of these controls lead to higher costs, lower profits, and a poor competitive position. So goes management's reasoning.

For these same reasons, we heard of companies working hard to make their professional employees more company oriented and more sympathetic to management's problems.[4] By contrast, we hear of few examples where working scientists have made a company more professionally oriented. Such movements apparently start in management, if they succeed at all. More often the professional employee apparently gives up and moves on to the next company, lured there by advertisements on "opportunities for creativity," "individual growth," and "professional development."[5]

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[3] *Business Week*, "Engineers and Scientists in Industry Feel Their Talents Are Misused," Oct. 24, 1959.

[4] W. H. Whyte, *The Organization Man*, Part V, "The Organization Scientist," Simon & Schuster, Inc., New York, 1956.

[5] According to one survey, scientists changed jobs on the average of once every 3.3 years. This would lead to a turnover rate of about 30% per year for the average scientific organization covered by this survey. See I. Hirsch and W. J. Oakes, Jr., "Increasing the Productivity of Scientists," *Harvard Business Review*, March–April, 1958.

Despite these resigned attitudes on both sides, many companies earnestly work to improve the situation. Personnel departments have been developed for professional employees alone. Engineers have been sent to school to learn more about management. Consultants have been retained for attitude studies, organizational studies, and product development studies. Management has hired and listened to researchers in organizational behavior. Management itself has returned to school to learn more about the motivation and management of scientists and engineers.

During this period, management representatives have also drawn upon another resource, one in which they typically place highest confidence. They have relied upon their own observations and diagnoses. They have observed and speculated, been baffled and enlightened. Experiencing both failure and success, management has tried to determine how best to bridge the gap between scientists and the organization. In a similar vein, management has tried to organize technical groups and departments in ways that benefited both individual and company. Company policies and procedures have been re-examined with regard to their applicability for technical groups. Engineering supervisors, as mentioned above, have sought to become more effective supervisors through outside study, training, and their own day-to-day persistence on the job. Nevertheless, the questions, queries, and uncertainties continue. The problems remain and will probably continue to grow with increases in technology and engineer employment. The over-all importance of the situation has been well expressed by Peter Drucker in a speech to business leaders: [6]

> What we have been talking about these last few years about the "management of engineers" or the "organization of a research department"—and as you know our literature is full of discussions of these questions—is, I think, a forecast of something that will be a general and chronic concern. For essentially, if our society is an educated society, then it is the integration of the professional into the business organization that emerges as the central social problem of twentieth century America.

[The study reported here] was designed to examine closely two engineering groups in two different organizations. [For convenience they are called Department A and Department B.] By taking two real life groups, we could avoid a common management objection raised over the study of experimental groups under artificial conditions. The two engineering groups described in this study were not artificial, nor were they studied under unrealistic working conditions. They were observed while on the job, and they were interviewed both on the job and off. They were compared and will be described in terms of their (1) organizational and community environments, (2) supervisors and management, and (3) individual members. [Given below are some of the implications of this study for management and certain implications for future research.]

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[6] P. F. Drucker, "Social Changes—What They Mean to Management," Harvard Business School, Boston, June, 1957. (Mimeographed.)

IMPLICATIONS FOR MANAGEMENT

Very briefly, our findings question the usefulness of management orientations which stress profits, productivity, and practicality *to the exclusion of other values. Organizational values, according to the findings of this study, may be overstressed and self-defeating in technical groups.* [Italics added.] Perhaps the management implications of this study (and the previous statement) can be examined by discussing the single concept of practicality. This value reflects management's traditional line of reasoning when challenged by the scientist-engineer and his Professional reference group. Management representatives defend and define practicality in the hopes of swaying scientist-engineers toward understanding the competitive realities of life. But they do more. Management is in a position to impose its own practicality structures on groups of scientist-engineers in industry, and these Organizational values raise problems. Our findings suggest their re-examination in terms of what is and what is not "practical" within organizational contexts. This suggestion comes cautiously, for the notion of practicality is management's own pride and province. Other disciplines and professions claim priority on other concepts (some in even greater need of re-examination), but business management lays traditional claim to the concept of hardheaded practicality.

From our point of view, industry's practicality concept can often be described in terms of some related components. These components include formal policies and procedures, careful organizational structuring, formalized supervisory responsibilities, and highly defined employee obligations. In this sense "practical" management stresses the importance of formal policies and procedures which define controls and boundaries so that "everyone" is relatively certain of who does what, when, how, and where. Such management structuring inevitably leads to downward influence systems and vice versa. Organizations are structured so that autonomy often has narrow limits. Likewise, supervisors are usually accountable for work group performance without a recognition of management's own downward influence or the group's status make-up as factors affecting both performance and satisfaction. Finally, department members are often expected to adhere to certain organizational procedures which limit interaction, participation, and sense of individual contribution.

These policies, procedures, and structures require the practical manager to seek greater certainty and clarification of the organization around him. Policies, systems, procedures, organization charts, supervisor accountability, and limited employee involvement all help management to build certainty and control within the organization. In some respects, this world of controlled certainty is useful, but as in Department A, it also tends to foster a related world of unanticipated rigidities.

The situation in Department A suggests that high emphasis on certainty and clarification promoted negative as well as positive consequences. For example, management rewards tended to relate more to social status position than to rated abilities.[7] Again, Department A's organizational structure seemed to foster competition between sections and section leaders when cooperation would better serve the needs of both. Early specialization served to block individual competence from growing beyond the boundaries of a particular job. Downward influence patterns generated similar restrictions. In its continued quest for practicality, management sponsored a *system of controls and logics which tended to lower performance, satisfaction, and opportunities for individual growth. . . .* [Italics added.]

Department B suggests a management concept of practicality in which management encouraged an organizational system with interdependent external and internal influences. This more open system stressed the need for mutual influence, high opportunity for nonrequired interaction, and individual autonomy. It also accepted certain kinds of uncertainty and ambiguity as beneficial. Supervisor B and his immediate superior both supported and behaved according to this system encouraged by Company B's management.

Within this situation, downward influence no longer becomes *the* practical approach. The uncertainties of status incongruence become more practical and encourage greater flexibility than does a social structure based on high status congruence.[8] Informal working relationships become more practical and less frozen than formally structured arrangements. Supervision can help as well as influence. Competition moves beyond the group and is replaced by relatively high cooperation within the group.

These and other Department B practicalities imply that business might well examine these less conventional notions of what is practical. More highly rational models of organizational efficiency and practicality apparently raise serious problems not solved in Department A's relatively closed system. The less status bound, more open Department B system tended either to solve or to avoid some of these same problems.

In summary, management can ask: what kinds and degrees of constraint and structure should be imposed on the activities, interactions, and sentiments of group members? To be sure, the more formal and formidable these constraints and structures become, the more management gains a degree of certainty and clarity. But certainty and clarity may make *impractical* demands on dynamic organizations. [Italic added.] Certainty and clarity from management's point of view in Company A led to higher frustration, rigidity, and apathy from other points of view. The implications for management are clear. In a world where man is increasingly educated for the sake and power of his intellectual contributions, business needs flexibility and a tolerance for ambiguity. Frustration, rigidity, and apathy become expensive, unproductive prices to pay in the name of organizational practicality. Consequently, the challenge: can management examine and work through *more* practical yet more open system values than those that lead to status rigidity and to downward influence? The record and experience of Company B suggest that they can. Organizations can move beyond dominant concerns for profit, productivity, and practicality in a narrow sense and encourage individual growth and open system relationships. Moving toward a more open system, however, makes certain demands upon both management and the scientist-engineer.

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[7] This relationship is reminiscent of bowling scores relating to individual social status and membership rank in Whyte's study of a street corner gang. See W. F. Whyte, *Street Corner Society*, pp. 255–268, University of Chicago, 1943.

[8] Status congruence, as used here, means a situation where there is close conformity between status in the management hierarchy and professional standing as an engineer or scientist.

In order to move toward relatively open organizational systems, management might well experiment. It could design and carry out its own research in organizational behavior as one way of systematically discovering what happens when greater autonomy is encouraged and a relatively closed system begins to open. Likewise, management can tentatively explore procedures that help build effective mutual influence relationships between status levels. Finally, interaction can easily be encouraged so as to extend beyond the confines of job requirements. These experimental steps can lead to both excitement and uncertainty. They can lead to relaxed relationships with scientists and engineers or to rationalizations for a return to a closed system. One thing is clear. The management willing to experiment and openly evaluate its experiences in these uncertain directions runs the best chance of succeeding. Although there may be few Company B situations, such organizations are present in our industrial world and more will probably develop.[9]

If, as we suspect, management begins to view relatively open systems as practical and productive in tomorrow's technological era, the behavioral scientist will also be interested. We might turn to these interests and to the implications this study has for future research in the field of organizational behavior.

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[9] One example, though in a nontechnical industry, is documented in Lawrence's study of a food chain which sought to move toward what we would call more open system relationships. See P. R. Lawrence, *The Changing of Organizational Behavior Patterns*, Harvard University, 1958.

IMPLICATIONS FOR FUTURE RESEARCH

In one sense, the conclusion of this or any research should form the beginnings of new efforts and new ideas for other research. One research possibility is clear and is mentioned above. This involves the study of management and technical groups as they work through an organizational change toward more open system relationships. . . .

Finally, the author cannot resist the private temptation to leap from the implications of this study to the world situation today. The similarity is too strong to ignore. In a sense, the world's underdeveloped nations are currently seeking inclusion in a more open system of nations. Under such conditions, mutual influence should replace the downward influence of communism, colonial policy, or military domination. Higher autonomy should replace communist or western world exploitation. Whether we like it or not, modern communication and transportation will soon permit high interaction frequency and range consistent with each underdeveloped nation's search for higher autonomy and influence.

The western world's twentieth century response to the above situation sometimes resembles the thinking of a management with closed system values. All too often we have treated human needs in other areas as subversive influences. Historically, we have sometimes done the same in our own industrial history. At one time, unions were "pink," worker grievances "socialistic," scientists "screwballs," and collective bargaining efforts contrary to the American way of life. Today we may more wisely separate emotional impressions from the realities of the industrial scene, and studies like this may contribute more realistic pictures of the industrial world by showing it from a systematic, though outside, point of view. Possibly, as we begin to learn more about our own organizational world, we can apply our knowledge to relations with other countries and cultures. Possibly, too, we can better understand and meet the needs of all men who seek autonomy, interaction, and mutual influence in their own underdeveloped worlds.

13. NEW CONCEPTS IN TECHNOLOGY AND ORGANIZATION

From J. R. Gass, "Automation and Technological Change in the European Economy: A Research Planning Memorandum," 1957, pp. 20–21. (Unpublished.)

It is a reasonable interpretation of industrial history that much of the technique of industrial management, including the structure and organizational forms that have been evolved, is a direct response to changes in the technical basis of production. At least there is a substantial element of truth in such a contention. What major changes are likely to arise out of automation as such, and out of the general and wider trend towards more highly capitalised and technically integrated plants?

Much of the theory of management organization, and in consequence much that is taught in management training courses is based on the assumption that there are certain general principles applying to all organizations, whatever the technical basis of production. This is now a matter of doubt. It has been suggested, for example, that the "line and staff" principle is not rigidly applicable to a production system where the speed of specialist technical decision is a key factor. As a special case of this general issue, the role of the foreman (as the first point in general "line" management) may be greatly modified, and even disappear in the sense we now understand it. It may be equally true that where the purpose of production is the rapid translation of new technical ideas into products, the military "line and staff" model may prevent the necessary flexibility. And further, such an organizational model, laying emphasis as it does on hierarchy and status, may prove to be a bad organizational framework for effectively harnessing the values and ambitions which are the incentive for scientists and technologists.

Recent research suggests that there may be substance in the above contentions. The difficulty is to see how these ideas can be developed to the point where they become useful to managements. One useful step would be to study management structure and organizational procedures in firms with advanced technology (chemical processing and like industries), since it seems likely that these industries have already developed the forms towards which the rest of industry is moving. A second and complementary possibiilty would be to get a leading management expert to review existing management theory from the point of view of its relevance to firms with different techniques of production. Such an authoritative review would have immediate practical usefulness and would help to pinpoint the directions in which research would be of most value.

One result of automation is likely to be a changed relationship between the production line operative and management, arising simply from the changed functional requirement of the operative. Although the operative on an automatic line no longer controls output, and is monitoring for most of the time, it would probably be wrong to regard him as a watchman. He has to have sufficient empirical understanding of the process to make sensible use of control information, to take quick and sensible action in the event of breakdown or emergency, and to cooperate with maintenance in the detection of faults. To do these things he probably has to understand and accept management objectives to a greater degree than in the past. In a real sense he may be the first line of management. His essential working links may be more with technical maintenance and general engineering supervision. Since such functional links are the determinants of the structure of working groups, it seems possible that instead of the group of operatives on repetitive work, "man managed" by a foreman, the basic working team on automatic processes will be the machine winder, maintenance technician and supervising engineer.

Such a change at the very base of management structure and organization has many important implications.

The highly capitalised, technically integrated plant inevitably increases the importance of some areas of management in relation to others. Notable examples are:

a. *Planning:* due to the need to operate plant as an integrated whole and to find outlets for high continuous output;

b. *Training:* because of the increased use of sophisticated technical skills which cannot be wholly produced in educational institutions;

c. *Maintenance:* arising from the greatly increased economic penalties of breakdowns and other stoppages;

d. *Continuous running:* because of the cost of shutting down plant and the high capital: labour ratio.

All the above are likely to lead to new developments in management technique.

E. MONEY AND MOTIVATION IN THE MACHINE AGE

As we saw in an earlier section, not only technology but the engineering approach to organization through scientific management has transformed the nature of work in the modern world. This is in part because of the new ways in which man is rewarded for his work or punished for not doing it. Taylor and his successors are the creators of the theory and practice of systematically tying increments of human effort to increments of financial reward. In other words, scientific management is the parent of the modern "incentive plan," a method of payment and a philosophy of payment little known two generations ago. Today such plans are very widely accepted by management—and by a considerable number of trade unions—in modern industry. In the section Mass Production and Scientific Management, the selection called "Three Technologics: Size, Measurement, Hierarchy," introduced the subject of this section, but here we shall take a fresh look and a much closer one.

A fresh look indeed is being taken by many persons today for two reasons: (1) traditional incentive plans, though still widely used, are causing increasing dissatisfaction both to managers and managed; (2)

many students of the subject, including industrial engineers, are suggesting that these plans no longer fit either the actual motivations of men or the kind of work world which automation, nuclear power, and other innovations have begun to give us.

One of the clearest and simplest descriptions of the typical incentive plan—together with the assumptions on which it rests—has been written by William F. Whyte in his book *Money and Motivation.* It is included as our first selection. After this introductory description, we quote further from Whyte's discussion of how the old theory of *measurement and economic motivation* falls down in the crucial area of "rate setting." This selection shows how "incentive systems" sometimes fail to motivate when they ignore the wider world of values and of relationships within which the plans operate. It is predictable that the sophisticated manager or the experienced engineer on reading this selection will say: "You are beating a dead horse. Everybody today knows what's wrong with the *theory* of incentive plans in this age of automation." But as Whyte remarks: An old theory "hangs around and . . . shapes man's thinking *until there evolves a new theory,*" and for that reason we urge the reader not familiar with the book to refer to it as a take-off point for further thinking and study in this area.[1]

Many of the points made by Professor Whyte have been validated by the investigations of others. A study of incentives in a steel mill by the author has been included as the second selection. Principles of incentive payment have been generally accepted in the steel industry by both management and unions. This case illustrates incentive problems on the strategic technical frontier between older methods of manufacture and new automatic ones. It suggests that earlier ideas, both of motivation and of measurement of human work, are now changing and that the change is taking place not because science or management is abdicating its prerogatives, but because the new technologies (stemming from physical science) demand more and more the application of the biological and social sciences to modern industry.

Ever since Taylor, the role of the accountant has been closely tied to the role of the engineer and to a changing technology. For this reason we have included a unique document as the next selection. It incorporates a very personal discussion by a comptroller of his own experience. Forced by circumstances to take a fresh look at his role in industrial society, he discusses the reciprocal relationship between cost accounting and the behavior of people in a modern mass-production plant. The selection also shows how a "fresh look" led him to change his own behavior.

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[1] An excellent review of modern incentive plans and of the literature about them may be found in R. Marriott, *Incentive Payment Systems,* Staples Press, Ltd., London, 1957.

To return to the subject of money and motivation, many companies are today seeking more appropriate methods of paying for work done in an age of ever-changing technology. Some are experimenting with new varieties of profit-sharing plans; others, like the International Business Machines Company, are putting hourly wage-earners on salary. One very large science-based corporation is conducting research to answer the question: "Just what are we paying for?"

1. With the new technologies in some departments, should we not be paying day rates rather than piece rates?
2. Would we not do well to put a larger portion of our factory personnel on salary?
3. What are we really paying for, or what would we like to pay for: skill, effort, seniority, professional or craft experience, education, flexibility, loyalty, or what?

Some of the most successful and challenging experiments in new methods of payment for an age of technology have been conducted under the aegis of the so-called "Scanlon Plan." An account of the plan, its theory of motivation, and how it has worked in practice is included as the next selection.

What is automation doing, what will it do to money and motivation in industry? As a partial answer to this question, we include as the last selection certain predictions from a memorandum by J. R. Gass.

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1. ORTHODOX INCENTIVE THEORY, PRINCIPLES AND PROBLEMS

From William F. Whyte, *Money and Motivation,* Harper & Brothers, New York, 1955, pp. 2–5, 200–202.

As represented by F. W. Taylor and his followers in the scientific management movement, managerial thinking begins with one of the basic assumptions of orthodox economic theory: that man is a rational animal concerned with maximizing his economic gains. Of course, no economist believes this assumption to be true to the facts, but the tendency has been to reason from the assumption as if it were close to actuality.

If we assume that man's goal in the factory is to make money, then it naturally follows that we can get him to produce more if we pay him in accordance with the amount he produces. Thus the theory of economic motivation leads directly to the development of a piecework incentive system.

The second major assumption is that each individual responds to economic incentives as an isolated individual. Under such conditions there would be no need to investigate the effect of fellow workers upon the individual under consideration. While most management people realize that this individualism is never quite to be found, there is a tendency to think that people should respond in this individualistic fashion and that management should encourage them to do so.

The third major assumption is that men, like machines, can be treated in a standardized fashion. While individual variations are recognized, it is assumed that there is a "one best way" to do a job so that variations in method of work can and should be eliminated. There are expected to be variations in speed and endurance, but by studying fast and slow workers an average is to be obtained for "the standard workman." The theories of scientific management are based upon standards: standard hours, standard machines and standard workmen, and so on. For example, an incentive engineer's handbook defines the standard hour in this way: "a unit of measurement of the amount of work expected of an operator or a piece of equipment in one actual hour at a pace equivalent to standard performance." It is interesting to observe the way in which machines and workers tend to be linked together as part of the equipment of the factory.

Management also seems to assume that machines and workers are alike in that they are both normally passive agents who must be stimulated by management in order to go into action. In the case of the machines, management turns on the electricity. In the case of workers, money takes the place of electricity.

Since the theory requires a system of economic incentives, it also requires people and procedures and policies to administer this system. If the worker is to be paid in terms of the amount of work accomplished, then it is necessary to have some standards of the amount of work expected. Management must arrive at a price to be paid for each unit of production. The price is generally established through the work of time-study men. Their first task is to see to it that the job is being done according to the most efficient methods. They then are expected to time selected workers on the actual job operation. The price per piece is set on the basis of these measurements.

Management generally adds two guarantees to make the system more attractive to the workers. In the first place, his regular hourly pay is guaranteed whether or not he makes the standard. Let us assume that his regular pay is $1.50 an hour and that the standard on this operation is 10 pieces an hour, which would mean a price for him of 15 cents apiece. Then, if he produced only 8 pieces he would still get his guaranteed $1.50, but if he produced 12 pieces he would earn $1.80.[1]

The second guarantee involves rates or prices set for the particular job.

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[1] There is a bewildering variety of incentive schemes in existence today. The example here is of what is known as a straight-line or 100 per cent incentive, where the same price is paid for each piece. There are systems where a smaller price is paid after the standard has been reached and there are others which pay a higher price beyond the standard. The straight-line incentive is probably the most common today, and we will deal with that. However, we will seek to avoid the complications of the technical side of incentive systems since this is a book on morale and motivation rather than one on incentive systems per se.

It is generally understood that the rate or price is not to be changed unless there has been a significant change in the machine or method of operation which would justify the establishment of a new rate. This is designed to assure the worker that the can produce an unlimited amount with no fear that in the future he will have to produce more pieces on the same job with the same methods to make the same money.

In spite of such guarantees, we find almost universally that workers set a quota on what constitutes a fair day's work and refuse to go beyond this amount even when it is well within their ability to do so. This situation exists whether the plant is unionized or not. It exists where the workers hate and distrust management. . . . It exists even in cases where the workers evince considerable loyalty for the company and for management in general.[2] . . .

Does the fault lie perhaps with the use of poor techniques in administering incentive systems? If management just used the "right" methods of time study and rate setting, would the problems be solved? The fact that these problems have existed down through the years, in similar form, in a great variety of factories, suggests to us that the fault cannot lie solely with poor techniques. The persistence and generality of the problems suggests that there is something basically wrong with the policies and procedures on which piece-rate systems are based.

Rate Setting: The Problem of Change

[The problem of rate setting] is particularly difficult because American industry is so dynamic. New machines and processes are constantly being created. Old machines and methods are constantly being altered. The rate that is acceptable today may be obsolete tomorrow.

How does management meet this challenge of change? The problem has two aspects. There is first the problem of changing a rate when a mistake has been made in the rate-setting process.

Workers expect management to revise upward a rate that has been proved to be too tight. Can managers similarly expect workers to accept the downward adjustment in a rate that has been set too loose? The *Supervisor's Guide to General Electric Job Information* is interesting on this point. Note the following paragraphs:

> The fact that rate setters sometimes have been wrong and rates have had to be cut should be faced squarely by the supervisors.
>
> No rate setter is perfect. However, it must be pointed out that these occasional mistakes are made on the up side as well as on the down side. No employee thinks it is wrong to adjust a rate upward when a mistake on the down side has been made.

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[2] F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge: Harvard University Press, 1939).

> There should be just as fair recognition of the necessity and right to make a downward adjustment in a rate as an upward adjustment.

This statement has a fair and reasonable sound. It seems just as fair to change rates set too high as it is to change rates set too low. But in practice how does management discover that a "mistake" has been made in rate setting? Workers have the impression that this discovery will take place only if they turn out exceptionally high earnings on the job. In fact, we know of cases where the industrial engineers were under instructions to take a new look at any job showing earnings over a certain figure. As to whether rate changes were then put into effect the record is not clear, but the regular appearance of these incentive engineers to check unusually high earnings could hardly have failed to create the impression that it was dangerous to go beyond a certain quota.

If we move from possible mistakes in the rate-setting process to consider changes in job methods and content, the picture becomes still more complicated. Most union contracts provide for changes in rates based on changes in job methods and/or content. But we usually find the qualifying adjective "substantial" or "major" describing the change. It seems generally agreed that management should not be allowed to change a rate on the basis of a trivial change in the job. If this were allowed, then management could make some trifling change in any job as an excuse for setting a new rate. In fact, we have heard workers in some plants charge that this was exactly the excuse that management manufactured and used.

In this connection it is interesting to note a comment by John Mills, an engineer:[3]

> Reward is supposed to be in direct proportion to production. Well, I remember the first time I ever got behind that fiction. I was visiting the Western Electric Company, which had a reputation of never cutting a piece rate. It never did; if some manufacturing process was found to pay more than seemed right for the class of labor employed on it—if, in other words, the rate-setters had misjudged—that particular part was referred to the engineers for redesign, and then a new rate was set on the new part. Workers, in other words, were paid as a class, supposed to make about so much a week with their best efforts and, of course, less for less competent efforts.

It is the function of the engineer to improve machines and methods so as to reduce the cost of production. Roethlisberger and Dickson have properly pointed out that low production on an incentive job may call it to the attention of the engineers, who will then try to improve the cost situation by changing the job. Thus it is not only high production and high earnings that bring a job to the attention of the engineers. Neverthe-

[3] *The Engineer in Society* (New York: D. Van Nostrand & Co., 1946), p. 93.

less, we can expect the engineers to pay special attention also to jobs where worker earnings are exceptionally high. If the rate is demonstrated to be loose, then it is a natural invitation for the engineer to come in to see if he cannot institute a change which would justify changing the rates so that management could get the same production for less money. It is not only the lure of cutting costs that operates here. Management is dealing also with problems in intergroup relations. If the rate for one work group is so loose that it permits them to make earnings well above that of their fellows at the same skill level, that situation in itself may lead to disturbances within the ranks of workers. One way of adjusting to this disturbance is through making a change in machine or work method and instituting a new rate.

Even if we leave out of consideration rate changes that are clearly motivated by management's desire to find an excuse to cut the rate, we still come face to face with major questions of judgment.

When does a change become a major or a substantial change? It is obvious that two men of equal good will and sincerity can hold different opinions on this point for many cases.

There is the further troublesome problem of a series of minor changes. It often happens in industry that a job will be modified step by step over a period of months or even years. No single change in itself would qualify as major or substantial, and yet the sum total of these modifications might change a rate that was average in earnings to one that was very loose. At what point in the series of minor changes should management be allowed to intervene with a new rate?

Even if all parties agree that the change in the job is so substantial that a new rate must be set, the problem is still far from a solution. Let us assume that the old job was yielding incentive earnings of 50 per cent over base pay. Let us assume that the average earnings figure on other incentive jobs was only 30 per cent above base. In setting the new rate for this group of workers, should the rate setter aim at a 30 per cent or a 50 per cent bonus?

The workers on the job and their union officers will naturally argue that the new rate should provide earnings equivalent to those under the old one. The management may well feel that the old rate was out of line with the general plant picture and that earnings on the new rate of 30 per cent above base are quite adequate. So, even if we assume that the rate setter would be able to predict accurately the earnings possibilities of the job—and we have seen how risky this assumption is—there is no easy answer to the question of what earnings he should aim to make possible. This situation opens up a wide area of conflict.

2. INCENTIVES IN TIME OF CHANGE

From C. R. Walker, *Toward the Automatic Factory*, Yale University Press, New Haven, Conn., 1957, pp. 52, 53, 161–175.

William F. Whyte, reviewing some of the problems of rate-setting under incentive plans, writes: "If there were no changes in machines and processes, the problem of rate setting would be relatively minor. . . . This area of industrial life would proceed rather peacefully. Our problem is particularly difficult because American industry is so *dynamic*. New machines and processes are constantly being created. Old machines and methods are constantly being altered. *The rate that is acceptable today may be obsolete tomorrow*." [Italics added.] [1]

The incentive problems associated with a time of technological change were brought out strikingly during the break-in period on the first continuous seamless pipe mill in the United States—Number 4 Seamless—at the Lorain, Ohio, Works of the U.S. Steel Corporation. For the first 18 months after the mill was opened, in January, 1949, it was operated without the incentive. This break-in period was hard on everybody. More arduous work, whether mental or physical, was being performed by men and supervisors alike than when the mill was finally broken in and running smoothly. If in the life of a mill such periods are brief, everyone takes them in their stride; if not, they take them the way the crews on Number 4 took them. The men had expected to work at base rates while the mill was breaking in, but by May and June of 1949 they were highly impatient for the installation of incentives. The industrial engineers, however, continued to feel that operations were not sufficiently normal to justify rate-setting. The response of the crews was a slowdown designed to pressure management into "putting in the bonus." Incentives finally went into effect in October, 1950. However, frequent and lengthy delays caused by mechanical breakdowns, as well as dissatisfaction with various aspects of the incentive plan itself, aroused considerable bitterness among the men and discouraged them from even attempting to "make bonus." Later, when the mill was running more smoothly, they began to increase their earnings although, as we shall see, they still had real complaints about the incentive plan.

The point that emerges is this: From the point of view of all the workers, all during the period when they went home with the greatest degree of mental and nervous fatigue, and when management expected their utmost cooperation, financial incentive for working, as the record shows, was the lowest—at first "no bonus" over and above base pay, and then for a time small incentive earnings. Later, with far less effort or anxiety, their incentive was at a maximum, rising at times to 35 and 40 per cent above base pay. . . .[2]

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[1] Whyte, *Money and Motivation*, Harper & Brothers, New York, 1955, p. 200.

Both men and management have in the past always taken such a situation for granted. Will they continue to take it for granted in an age of accelerated technological change?

Now turn to the same period from management's point of view. The overhead on as costly and complex a mill as Number 4 is very great. Every hour, day, or week in which the mill is down or is operating below the break-even point is costly. It was during this experimental period of operation, when management was trying every device to get the mill rolling, that the men were at their most cynical about the mill's future, and that the crews welcomed shutdowns instead of making every effort to prevent them. . . . In addition to lack of faith in this period, there was lack of financial reward.

What of the future? The author hazards the prediction that as American industry advances further and further into the technological work environments of the future a way will be found to provide work motivations for break-in periods, when the demand for faith, imagination, nerve, and sometimes muscle is often the greatest.

A few of the possible approaches to this problem may be suggested. One of them is to associate workers' interests closely with management's, so that they will be willing to bear the risks and frustrations of a long break-in or experimental period. Profit-sharing plans and yearly salaries are ways of making this approach. The record of so-called Scanlon plans, which are based upon rewarding workers for reducing unit labor costs, and which encourage worker participation in solving production problems, is suggestive reading for managements seeking a solution to this problem.

Closely related to the question of continual change in process, product, and earning power is the question of mechanical delays. . . . Under the incentive plan in force on Number 4, the industrial engineers had handled the matter of mechanical delays as follows: They kept a record of the time taken up by mechanical delays over a period of months, then calculated a daily average and "absorbed them" in the rate of pay. That is, the men were paid enough more in their individual rates so as not to be penalized for the time the mill was down due to no fault of their own. This arrangement appeared eminently fair to the industrial engineers who had designed the plan and who administered it. It did not appear so to the men. Every man in each of the three crews felt angry and indignant. There were no exceptions. The following comments illustrate what was on the workers' minds:

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[2] It has been stated in defense of incentive plans of this character that the later enjoyment of high earnings under the plan is a "reward" for working hard during the break-in period and after. This in the author's judgment does not meet the difficulty. A carrot for a donkey is not an incentive if he is promised it for next year. One reason it took the workers on Number 4 so long to "operate the mill at normal" was that the men wanted the reward here and now if they were going to be "financially motivated."

> The bonus plan is definitely not a better system on Number 4 than in the old mills. We work our fool heads off and then something happens and we can't make it. You take like last night we had a mill change and we were doing it pretty fast and would have made good bonus. We went along for five hours on good production and we were on our way to make, I would say, about 25 per cent. At 8:30 we had two mechanical breakdowns. That took the steam out of everything we were working for. We knew right then and there that we were never going to make 25 per cent bonus, so the rest of the night we just loafed along.
>
> If you go like mad and then a delay comes, everybody knows they can't make a nickel. I do think that the company is making a mistake on that whole business of the delay time. . . . They'd be surprised if they would figure out in a turn how much pipe did not get made for them because the men just didn't have the incentive to put out.

These comments can be further clarified by simple arithmetic. Assume a man's base pay to be $2 per hour, and his incentive earnings 25 per cent over and above his base pay. It is obvious then that if he worked at incentive pace for eight hours, and if there was no mechanical delay causing the mill to shut down, he would then net $20, instead of the $16 he would have earned had he not been working at an incentive pace. The incentive offered enables him to earn ten hours' pay (at $2 an hour) in eight hours. But consider what happens if there is a substantial mechanical delay during which the mill does not operate. Assuming that the delay occurs at the beginning of the fourth hour and lasts for two hours, his working day, hour by hour, will look like this:

Hours	Base rate and possible incentive earning	Base rate
1st	$ 2.50	$ 2.00
2nd	2.50	2.00
3rd	2.50	2.00
4th	0.00	2.00
5th	0.00	2.00
6th	2.50	2.00
7th	2.50	2.00
8th	2.50	2.00
	$15.00	$16.00

The two contrasting columns of figures tell what was on the minds of every worker on each of the crews on Number 4 Seamless Mill. The first three items in column 1 mean that the worker had worked at incentive pace and *earned* $2.50 an hour, or 25 per cent above his base rate. The zeros at the fourth and fifth hours means that he had earned nothing during those hours because the mill was down. However, he will receive $16 for his day's work, not $15, because in accordance with his union contract he must be paid his base rate so long as he remains in the mill *ready* to work. But that is no more than he would have received had he not spurred himself to work at an incentive rate for the sixth, seventh, and eighth hours. He was saying in effect, "If management wants me to work at incentive pace after a mechanical delay which isn't my fault, they'll have to 'clock out that delay' and pay me something for it, so I won't lose my whole bonus."

What does the industrial engineer say to the two columns of figures and to the workers' argument? Essentially this: "There's nothing unfair about the arrangement. The delays have been carefully averaged out, and the man has been paid for that average in his regular incentive rate. He has nothing to complain about; in fact he should have the incentive to work right through the day at incentive pace." This comment, as well as the workers' comments, deserve study because they throw light on the problems of financial incentive plans during both periods of technical change and other times. The second sentence in the industrial engineer's statement is simply a statement of fact, and it appears, at least on first examination, to justify the first sentence asserting the fairness of the arrangement. The key, however, to the engineer's point of view lies in the last part of the last sentence, "he *should have the incentive* to work right through the day at incentive pace." Here the industrial engineer and his plan have somehow jumped the track of their purpose of *motivating* the crews to produce more pipe. He has shifted to a moral plane. The plan is clearly *not* motivating them but it *ought* to. Why *ought* the worker to be motivated? Because mathematically the plan is correct and the engineer has accounted for those delays. But psychologically it couldn't be more wrong. And this was conceded at once by all Number 4 supervision and most of local management. We need to add a word at this point in defense of the plan and of the industrial engineers who devised and defended it. In mills where delays are short and few and far between, Number 4's method of absorbing, as against clocking out, delays works perfectly. In short, they had precedent behind them.

The lesson or lessons of the delay episode on Number 4 for the period we are discussing would appear to be these:

First, it is quite possible that in a given situation a proposed incentive plan may be mathematically correct but psychologically and humanly wrong. Therefore, where application of an incentive plan results in the development of *unforeseen* and mutually unacceptable features, it is advisable that provisions be made for prompt adjustment or alteration in the plan to correct such situations before they become serious. Under some circumstances an incentive plan may actually become an anti-incentive influence!

Second, the grave dangers in inflexibility are pointed up. The method of calculating delays, a minor feature in the total incentive plan, became a *cause célèbre* for many months on Number 4 Mill, and was all but unanimously regarded as the greatest stumbling block to higher production and good morale in the whole department. And yet there appeared to be no possible principle or procedure under the terms of the plan by which any compromise could be reached. This is the danger of formalism and overstandardization, which frequently affect large industrial organizations.

Third and finally, a plan devised for a relatively stable situation often fits badly into a dynamic one. Even after the delays were so few as hardly to be an issue, the men feared and resented this feature of the plan. Why? "Management plans to make some more technical improvements on the mill," they said. "That will mean more delays, and so those improvements will mean less bonus for us." This suggests a very much larger and more crucial issue than the delay question with which management must grapple in an age of more and more rapid technological change. How can workers be brought to welcome rather than resist periods of rapid and continual technical change which are likely to characterize the age of automation?

One of the commonest and most persistent criticisms of Number 4's incentive plan by crew members and also by certain members of supervision was that the coverage was too narrow. . . . At the beginning only the twenty-seven members of the hot mill crew [out of a possible 150 men] were included in the bonus. A first step in broadening that coverage occurred when the crane man and crane follower were brought in through a separate incentive application. But the crews continued to agitate for an even broader coverage; they wanted maintenance, both mechanical and electrical, to share. Why were these men so anxious to share the benefits of Number 4's growing prosperity with their fellow workers? The reasons were both economic and social.

Their economic motivation the crew members continually made explicit when interviewed. They insisted that the attitude and competence of indirect labor, especially mechanical and electrical maintenance, had a direct bearing on the amount of bonus earned by every member of the three hot mill crews. If maintenance men were to have as great an economic interest in "keeping the mill rolling" as the crews had, repairs would be made faster and better. So much for the economic reasons for advocating a wider coverage. What else? It is common knowledge that the average hourly wage earner is sensitive to and usually acutely aware of the rate of earnings of his fellow workers. The consensus of Number 4 crews was that indirect labor was entitled to share in the mill's earnings, since these men palpably and substantially contributed to them. Even when it was suggested that the crews might earn more by keeping maintenance from sharing in the incentive take, the men still insisted that coverage should be broadened.

As industry becomes more automatic, the author believes, the tendency will grow to recognize the cooperative and interrelated character of every man's contribution to production, rather than meticulously to isolate and pay for segments of individual effort. In fact as the trend toward automatic machinery advances it may be said that the distinction between direct or productive labor and indirect or nonproductive labor tends to lose its old significance. All labor becomes concerned with the uninterrupted maintenance of a high production rate.

What happened on this question on Number 4 Seamless is of great significance to this inquiry. Following the period covered by this history, the steel corporation greatly extended incentive coverage of hourly wage earners in Lorain. This was in accordance with corporate policy. On Number 4 Seamless the policy has resulted in the coverage of the roll setup man and helper (highly skilled nonproductive workers) and of all mechanical and electrical maintenance workers. Certain laborers are not yet covered at this writing, but it is management's plan and policy to see that all personnel in the mill are covered. Details of this development and its full implications are beyond the scope of this case history. From the standpoint of this inquiry the policy appears to give objective recognition to the interdependence of all categories in a modern steel plant.

As a last note in this brief review of incentives in a time of change, some light may perhaps be thrown on the new character of work in a semi-automatic mill by noticing the men's criticism of management's methods of measuring their work. What they said in various ways may be summed up as follows: "All right, if we're only going to get paid for that part of our work which management can measure, then that's the only work we'll do."

The simplest way to understand what was on these workers' minds is to consider their comparison between work on the old mills and work on the new. The former, to put it broadly, demanded muscle; the latter brains. Or "You do less physically on Number 4, but on most jobs you have to think more." And when they considered "thinking," it was obvious that here was something which, unlike muscular movements, was very difficult to measure. The real point that occurred to them, however, was that it was difficult to assign a *time* for thinking, a time when the brain, like the muscles, would cease to be active and enjoy "idle time," as the muscles did under the incentive plan. One remembers the comments that when one quit work on the old mills only the muscles were tired, but now "my brain keeps on working." Again, apropos of measuring work,

> I get my best ideas about my job and the new passes for the nine-stand when I'm in the can, or at lunch, or on the way home. But under the incentive plan that isn't "true work."

The designer of the incentive plan has an answer for this operator:

> We accounted for your ability to think by giving you a high job class, and your high job class is reflected in your incentive earnings under the plan.

That appears to be a reasonable answer. Why doesn't the worker "see" it? Having talked with the crews and their supervisors for over four years, I would say this: Instinctively the worker feels that some of the demands on his abilities are different ones in this new work situation, so management should *somehow*—he doesn't say or know how—give recognition to that difference He doesn't know how, I repeat, but he thinks about it critically whenever the incentive plan, with its necessary emphasis upon an elaborate apparatus for *measuring work,* is being discussed.

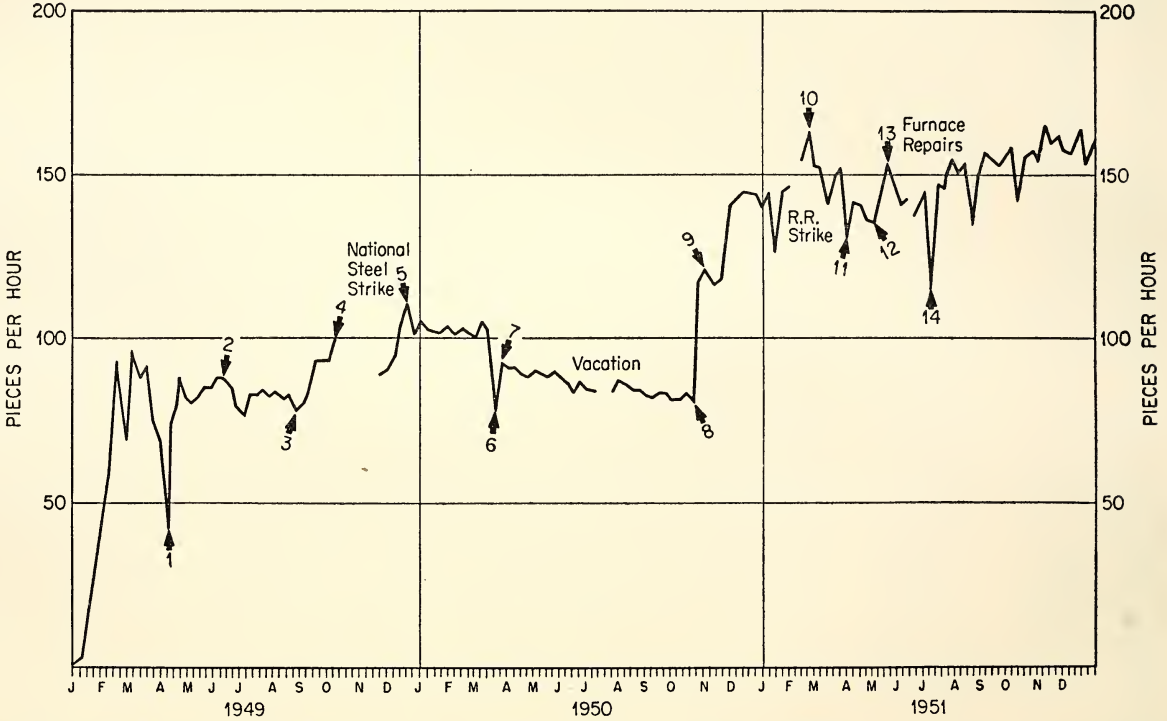
Perhaps a better illustration of this same general criticism of the plan comes out of the workers' comments on "watching" instead of doing. On the old mills there was far more "true work," to use a technical phrase, that is work which can be strictly measured, like the motions of the piercer plugger, by the stop watch of the time study man. In contrast, with the automatics on Number 4, the men point out, "most of the time we do nothing but watch."

"I know that," replies the industrial engineer, "and that we call 'attention time.' We measure that and credit you for it."

"We don't think," the worker answers, "that in a mill like this you can really tell the difference, the way you say you can, between just sitting on your tail in front of the machine, which you call idle time—and for which your plan gives a man no credit—and being alert, thinking and ready for action, which you call attention time. Take the stripper man, for instance. You call it attention time when the pipe is going through his machine and the conveyors around him. You call it idle time *after* the pipe has left his area. But in those seconds—under some circumstances they're minutes—the *good* stripper man is on the alert for signals from other areas, and planning what to do next."

A certain kind of answer to this criticism is implicit within the terms of the plan. If what the worker says is true, then could not the inequity be corrected by extending or increasing attention time credit and reducing the amount of idle time for which no credit is given? And would not this and similar "corrections" remove all reasonable objections to the plan? Not

AVERAGE WEEKLY PRODUCTION—No. 4 SEAMLESS MILL



Numbers 1, 2, 3, etc., on curve correspond to explanations of *dips* and *rises* in production given in text of the book from which this selection was taken. These dips and rises were caused by mechanical difficulties. All the others were the results of human situations, such as the one connected with the "delay question" as explained in the text.

if my interpretation, based upon a good many hundreds of conversations over several years, is correct. What the crews are really saying, I believe, is this: "Here on Number 4 you have a *new* setup. Mechanically, electrically it is designed along *new* lines, and in accordance with *new* principles. It is the first continuous seamless tube mill in the United States. To run it successfully we have to act differently, think differently, feel differently. Our relations with each other are different, our relation with our bosses is different. There should be some way in which these differences are recognized in the way management acts toward us and in the way we are paid."

I have studied complaints of workers about incentives for a great many years. As a rule the complaints of the workers and of their union representatives have been that the standards were wrong or unfair and that the rates were too "tight." A few workers on Number 4 complained of a few standards, but the most striking thing about criticisms of the incentive plan was that nearly every worker started by saying: "I have no kick about the standards or the rates; the industrial engineers have been fair," and so on. No, the criticisms were of a different character, as in the present instance, when they challenged the practice of measurement itself.

Managements that have had the most experience with the new age of automation would tend, I believe, to agree with some of the criticisms of Number 4 crews. In an article entitled "Automation and Industrial Relations" Baldwin and Shultz make a number of comments which are interesting in the light of Number 4's experience. Automation, they suggest, challenges the still prevalent management philosophy which says:

> . . . (1) break the work process down into the smallest possible components, (2) fit jobs into a rigid structure that emphasizes the *duties and the boundaries of the job rather than its part in the process,* and (3) put everyone possible on an *individual or small-group incentive system* gearing pay to output on the particular job. This philosophy inevitably has tended to identify the individual with an ever more narrow task, *giving him positive incentives to restrict his interests and no incentive at all to think beyond his immediate work environment.* . . .
>
> Automation is likely to challenge these habits of thought fostered by discontinuous and highly specialized methods of production. . . . [it] requires a new way of thinking . . . that emphasizes continuous movement of work through a total process rather than stop-and-go progress, thought of as the sum of independent operations.[3] [Emphasis supplied.]

Baldwin and Shultz then quote one management group which suggests that seniority standards will undergo an evolution stemming from "the need for a more flexible work force." They comment:

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[3] George B. Baldwin and George P. Shultz, "Automation: A New Dimension to Old Problems," Industrial Relations Research Association, *Proceedings of the Seventh Annual Meeting,* Detroit, Dec. 28–30, 1954, pp. 124–5.

> In this view, the development of a work force *willing and able to adapt itself to the changing needs of an evolving work process* would mean more than application of seniority protections to broader units of work. As a standard for continued employment, "ability to learn" would gradually replace "ability to do" the job. [Emphasis supplied.]

Summary:

In this brief review of incentives in a time of technical change, we have turned up more questions than answers. If questions are good enough in any inquiry, they should point *toward* the answers. That at least is our justification for asking them. To sum up the questions:

How can we provide an incentive for the difficult, break-in period characteristic of these times of rapid technological change?

How can financial incentive plans under conditions of rapid change be prevented from turning into anti-incentive plans?

How can sufficient flexibility be introduced into the principles of any plan and into its administration so that such a relatively minor crisis as the delay question can be promptly resolved and not allowed to fester and disrupt months of operations?

How can thought and effort which are impossible or difficult to measure but of enormous importance both to labor and management be encouraged and rewarded?

How can incentive plans be administered so as to take account not only of financial but of other motivations involving the whole and not simply economic man?

3. THE COMPTROLLER TAKES A FRESH LOOK

From Robert H. Guest, "Organizational Change: A Study of Managerial Succession," unpublished doctoral dissertation, Columbia University, New York, 1960, pp. 109–113.

One of the major control activities in any industrial organization is that of accounting. Budgets and cost figures dictate to a great extent what the organization as a whole or the individual supervisors in it can or cannot do. The most direct link between the local assembly plant and the corporation is through the comptroller. At Plant Y, members of local management were fully aware that even though the plant comptroller, for administrative purposes, reported to the plant manager, he had to enforce rules and regulations set at higher corporate levels.

A frequent complaint heard from operating supervision in 1953 and previously had been that the information coming down from the comptroller's office, with particular respect to efficiency reports, had been misunderstood, meaningless, and as one member of management put it, "downright harmful." Operating supervision recognized that in order to operate efficiently, it was critically necessary to have periodic information which would allow them to know whether or not they were operating according to their budget and according to standards. However, they felt that the figures showing poor efficiency had been used by top plant management as a personal indictment of their particular operation, when, in fact, the cause of inefficiencies had often been due to circumstances beyond their control. The comptroller's department had been looked upon as a distant impersonal group of accounting machines whose personnel understood little and cared less about the practical usefulness of figures to the operating departments. Because these figures had been used as a "bludgeon" by the plant manager, supervisors had come to look upon the comptroller with deep fear and suspicion. As the plant engineer observed: "Everyone played the cost figures close to their chests."

By 1956 the relationship between operating supervision and members of the comptroller's department had changed considerably. "Being in the know" was a frequent remark heard from supervision with respect to cost control figures. The process by which this change came about has many parallels in the changes observed in other functional relationships.

How the change process came about is best illustrated by the following detailed comments of the comptroller himself.

> You know, most people in the shop always think of the comptroller as someone up in some corner office dealing with a lot of mysterious figures, and getting out financial statements, and making payrolls, and that's about all. This is perhaps common to the operation of any comptroller, but I recognized soon after I got to Plant Y that I would have a chance to do some of the things I long wanted to do. Mat Cooley [the manager] told me right off that he felt that our department could be a lot more helpful to the operating people and the service departments. In fact, the way it worked out he would frequently come up and grab me and tell me that we were going to take a walk through the plant. There were several weeks in which we went through the plant together two and three times a week, sometimes twice a day.
>
> I spent a lot of time talking not only to the department heads and the superintendents, but with the general foremen and all other foremen as well. I spent a lot of my time trying to find out what the figures that came out of my department meant to the operating and service departments, and then discussing ways in which those figures could be more meaningful. I tried to demonstrate what was behind the figures and how we calculated them, but it became apparent that, although they got to understand how the information on efficiency and costs and other things was constructed, they were not necessarily the types of information which would be useful to them in their day-to-day work. We found so often,

> when you really got the foremen to open up, they thought that some of our figures were lying. The figures in themselves were not wrong, but they certainly weren't useful to them, which amounts to about the same thing. For example, if you simply come out with a figure and tell a foreman that he is ten per cent over standard costs, that doesn't mean too much to him unless he understands why. As we found out in our talks with the foremen, there could be six or seven different factors which would account for a foreman's being over standard, and some of these factors could be beyond his control. *Yet he was punished for them even when they were beyond his control.* We worked a long time figuring up a formula which the foremen and general foremen and superintendents could use to analyze efficiency figures quickly. Also, we broke down the efficiencies, after we got the overall figures, into individual elements and laid a program out on that basis. *Next, we got all of supervision in and presented the idea to them, showing that the idea had basically come from our talks with them.*
>
> Our experience proved to me that a carefully devised system of financial control is not necessarily a real system of cost control. Real cost control operates on the philosophy that we adopted for the supervisors responsible for the different areas. In other words, *the first thing to do is to get to know their needs as they see them and give them the figures that are tailored to these needs.* At the same time, of course, we continue to send to central headquarters all the weekly and monthly reports in just the form which the division and the corporation requires. [Italics added.]

From the comptroller's remarks, certain phases in the change process may be discerned. The first phase was marked by direct and informal contacts of the comptroller and plant manager with foremen, general foremen, and other supervisors. From these contacts the comptroller learned that the accounting control systems were not only misunderstood, but that they were regarded as a further threat to a supervisor's job security.

In the second phase, the comptroller and his staff sought to explain how the system worked and how the figures used to measure efficiency were obtained. It became apparent that, regardless of how much the system was explained, members of supervision questioned the usefulness of the figures for their own particular operations. They continued to view the accounting function as something required by the division and corporation for purposes which were of no direct help to plant-level supervision.

The third phase saw the comptroller and his department establish a system of reporting which was based on the immediate needs of plant supervision. He was, of course, required by regulations to maintain a rigid and standardized reporting system according to procedures laid down by higher authorities, but paralleling this system he instituted another method of internal reporting.

Notice that the new system evolved from many discussions with those who would be most directly affected. It was looked upon as a measure of assistance, and not simply as another set of "red-tape" regulations.

Members of supervision reported that the new system introduced a degree of predictability which had not been possible before. As in the case of other changes which took place at Plant Y, the increase in the time perspective made it possible to plan, and such planning reduced the number of daily crises.

The increased coordination between the comptroller's group and other members of the organization had an important effect on Plant Y's relationship to the division. All of the major physical changes which improved Plant Y's performance required approval of the division. The comptroller's department was ultimately responsible for "presenting the case" for division approval. The comptroller described how increased involvement in technical decisions helped him in requesting appropriations for capital outlays. As he described it:

> I got into another kind of activity which is different from the kind usually thought of for a comptroller. Cooley would often bring me in when they were going to make some kind of rearrangement in the shop. Take like in the trim shop when we made those big changes. I and my people would often go down as a group with Cooley and the heads of other operating and service departments. We would observe the operations themselves to see why the changes needed to be made. Even though I didn't know much about the operations themselves, I was always asked to express my opinion. My job, of course, was to work up the information to be submitted to the division for money outlays. It meant a lot more to us, in writing up the request for appropriations, when we had the actual experience of seeing the problem itself and in having a part in making suggestions. In other words, we again got away from the business of sitting in an office by ourselves. We were cut in on the deal.

By being "cut in on the deal" members of the comptroller's department were in a position to present a more convincing case to the division and, as it happened, almost no requests were denied.

4. THE SCANLON PLAN

i. Introductory Note by the Author

From the standpoint of money and motivation in the machine age, the fifty-odd Scanlon plans now in operation under very varied conditions are believed to be significant for the following reasons:

1. They eliminate the kind of grievances which often accompany the usual incentive plans, such as those discussed in the earlier selections in this section.

2. They appear to do so by adopting a theory of motivation better suited to the complexity of manufacturing companies operating under modern conditions.

3. They answer operationally the hard question which plagues most profit-sharing plans: What should management do when there is no profit to share?

4. They are successful in solving the problem of "overcoming resistance to technological change."

Perhaps the best brief presentation of the plan, one which includes history, principles and a case study, is the story of the Lapointe Tool Company entitled "Enterprise for Everyman." This is the first selection below. The second selection appraises the plan and industry's experience with it in the light of the findings of social science. This appraisal was written by Professor Douglas McGregor of MIT.

ii. "Enterprise for Everyman" [1]

From Russell W. Davenport, "Enterprise for Everyman," in Frederick Lesieur, (ed.), *The Scanlon Plan*, Technology Press, MIT, Cambridge, Mass., and John Wiley & Sons, Inc., New York, 1958, pp. 17–34.

There is nothing about the Lapointe Machine Tool Company that would lead the visitor to suspect that it houses the makings of a far-reaching management-labor revolution. It is a small, neat factory in Hudson, Massachusetts, where the executives walk up three flights to get to their varnished offices and most of the 350 employees eat lunch at home because they live nearby. Founded in 1903 by a French-Canadian named La Pointe, it was later purchased by John J. Prindiville, whose son, big, six-foot-six John Jr., is now President and owner of the equity stock. It is a modest enterprise with a reputation for high quality; there is even a trace of modesty in its boast that it is "the world's oldest and largest manufacturer of broaches and broaching machines." Yet the social achievement at Lapointe is something to make one pause and consider, for the discoveries that its management and union have made concerning the enterprise system could have repercussions around the civilized world.

Labor relations at Lapointe were just about like labor relations anywhere else, which is to say that there was mistrust on both sides leading on occasion to ill will. There was constant trouble, for example, over the piecework incentive system. . . . There were numerous production delays, spoilage was too high, and deliveries were bad. In short, the picture was a typical one as industrial relations go—worse than some, not so bad as others.

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[1] Reprinted by special permission from the January 1950 issue of *Fortune*. Copyrighted 1950 by Time, Inc.

In 1945 the plant was organized by the United Steelworkers, and about a year thereafter the Steelworkers called a national strike for a postwar wage increase. The Lapointe contract still had six months to run, and many of the men didn't want to go out anyway. However, the decision was to strike. Management thereupon sought an injunction, on the ground that the contract had been violated, and won a favorable decision from Judge Charles C. Cabot of the Massachusetts Superior Court. The union was enjoined from picketing the plant or otherwise interfering with operations. Early in April the strike at Lapointe ended. But there was bitterness in the air, and the situation was not improved by the realization that the machine-tool industry, after its war boom, had fallen on lean times. The unsettling possibility of a layoff hovered constantly over the shop.

It so happened about this time that Jack Ali, then president of the union, picked up a copy of *Life* (December 23, 1946) and his eye fell on an article by John Chamberlain with the intriguing title of "Every Man a Capitalist." Mr. Ali read it. It told about a small maker of steel tanks called the Adamson Company, where union and management had come together to install an amazing productivity plan, with the result that the company's profitability had increased two and a half times and the men had taken home bonuses ranging up to 54 per cent of a high basic wage. The author of the plan was one Joseph Scanlon, of whom Mr. Ali had never heard. However, he took the article to the union executive committee and together they became tremendously excited. After two evenings' discussion, the committee got in touch with Executive Vice President Edward M. Dowd, second-in-command to Mr. Prindiville—a big man, up from the ranks, whose intimate knowledge of the broaching business is matched only by his surefooted understanding of the men in his shop: Mr. Dowd turned a willing ear to what the committee had to say and on reading the article was deeply stirred.

There then followed some very active weeks. Messrs. Dowd and Ali journeyed out to East Palestine, Ohio, where they went over the Adamson plan in detail. They discovered that Mr. Scanlon was now teaching at M.I.T., scarcely forty miles from Hudson, and they presently made their appearance in his office. Mr. Scanlon, in turn, sent them to Roy Stevens, the regional field representative of the United Steelworkers. When they had obtained this gentleman's blessing they returned to the Scanlon office and began to dig down to bedrock. In the meantime Mr. Dowd had had frequent conferences with Mr. Prindiville, who was at once interested, and after some deliberation gave them the green light. Negotiations with the union were begun. And by December 1, 1947, the Scanlon Plan was installed at Lapointe.

The Scanlon Development

Now the Adamson experiment that started this chain of events was no mere accident in labor-management relations. It had its roots in the painful Thirties, when a group of labor leaders in the steel country evolved certain principles that have within them the power to revolutionize labor's relationship to enterprise, and vice versa. One of these leaders was Joseph Scanlon, whose versatile career included cost accounting, a spell as a professional boxer, a return to cost accounting (his basic profession), and then a shift over to the production side as an open-hearth worker. In 1936, during the formation of the S.W.O.C., Mr. Scanlon was on the open hearth of a marginal steel company, where he took a leading part in the organizing drive and was elected president of the new local.

Like many other steel manufacturers, this company was close to the rocks in 1938. Costs were high, the ink was red, liquidation seemed inevitable. Mr. Scanlon and his fellow union officers felt that something had to be done. They persuaded the president of the company to join with them in a visit to Pittsburgh to see Clinton Golden, then vice president of the Steelworkers and Phil Murray's good right arm. . . .

Mr. Golden advised them to go back and try to work out a plan by which union and management could join together to save the enterprise. And the upshot was a pioneer union-management productivity plan, which provided that the workers would get a bonus for tangible savings in labor costs. Despite the fact that the primary aim of this plan was merely *survival,* it worked almost like magic and became the seed of all of Mr. Scanlon's future work. Costs were cut so much that the company actually began to make a profit, and the workers got a bonus to boot. One suggestion by the union production committee, for example, cost less than $8,000 in new equipment but saved about $150,000 in one year.

Scores of other companies doing business with the union found themselves in this same tough position in the late Thirties. Primarily to save the jobs of union members, Messrs. Murray and Golden brought Mr. Scanlon into the national headquarters to work on these cases. Sometimes at the request of the company, often at that of the union, productivity plans based upon union-management cooperation were installed in forty to fifty companies. The largest of these early-period plans was at a basic steel company employing about 4,000 people; the smallest was at a water-heater company with 150 employees. According to Mr. Scanlon, "The successes were just as marked in the larger companies as in the small ones."

Out of this work came a book—*The Dynamics of Industrial Democracy,* by Clinton S. Golden and Harold J. Ruttenberg—and a proposition. The proposition was that collective bargaining, as thus far developed, was a primitive affair and that the future task of labor and mangament would be to evolve a more mature relationship. In this new relationship collective bargaining would include, not merely wages, hours, working conditions, etc., but intelligent cooperation between the bargaining parties. Such cooperation could not be expected if the workers were shoved to one side, kept ignorant of the business, and treated as pawns in a game going on over their heads. A new principle must be introduced, which has since come to be called the principle of *participation*. . . .

Unfortunately, when he uses the word participation, the average executive usually has something rather superficial in mind. He seeks to develop in the worker a *feeling* of participation, a *sense* of belonging. But is this quite honest? To make the worker feel that he is participating without giving him a real participation is, after all, to fool him; and deception is a flimsy, not to say an inflammable, foundation for industrial relations. Real participation consists in finding a means by which to reward labor for any increase in productivity and *then in building around this formula a working relationship between management and labor that enables them to become a team*. Once a team has been established, it is found that labor's prime interest, just like that of management, becomes *productivity*.

Such, at any rate, was the fruitful vein that Messrs. Dowd and Ali had come upon at the Adamson Company, the most spectacular of the Scanlon developments. The performance of Adamson, indeed, had attracted the attention of Douglas McGregor, then head of the industrial-relations section at M.I.T., and Mr. McGregor had persuaded Mr. Scanlon to come to M.I.T. There, with the help of economists, engineers, statisticians, and other experts on the M.I.T. faculty, Mr. Scanlon's work entered a new phase, in which he [drew] upon his vast experience in the labor-management field to give advice in the installation of real participation plans to those companies that [sought] him out.

The Formula

The first task in the application of the Scanlon plan is to find a "normal" labor cost for the plant under consideration and then to devise a means for giving labor the benefit of anything it can save under that "norm." In every case, therefore, some kind of link must be found between the worker and over-all shop productivity. Because every company is different, the nature of this link differs in almost every case; and because labor usually objects to having its costs accurately measured, some of the accounting handles that Mr. Scanlon has used are rather weird. At a manufacturer of silverware it is ounces of silver processed; at a wholesale warehouse it is tons warehoused; at a steel foundry and machine shop in the Deep South it is pounds of castings produced. At the Market Forge Company, a versatile steel-fabricating shop in Everett, Massachusetts, it is a calculated percentage of operating profits per month.

This last method, linking laborsaving to the profit and loss statement, is of course the basis of many profit-sharing plans. But Mr. Scanlon [felt] and Market Forge itself agrees, that it is the least desirable of any of the links, because the connection between the worker's productive efficiency and the final profit is too remote for many to grasp. It was adopted at Market Forge because the types of jobs coming into that shop are so variable that a labor-cost figure was impossible to determine. Notwithstanding this seeming weakness, a high level of participation has been developed at Market Forge, where more than 300 recorded suggestions for improved productivity have been put into effect in the past two years.

At Lapointe, where measurement was relatively easy, Mr. Scanlon decided on the most direct and understandable accounting handle—the ratio of labor cost to total production value, the latter figure being equal to monthly sales plus or minus the change in inventory. Since this labor ratio is a highly competitive figure, Lapointe [did] not make it public. However, the principle can be illustrated, and all the Lapointe moves intelligently followed, by taking the average for the whole machine-tool industry. According to the Department of Commerce the ratio of wages and salaries to the value of shipments for the entire industry for 1947 was 40.7 per cent—which, to speak in round figures, we may call 41 per cent. In actuality, the company felt that the "norm" derived from its war records was too high, and the union consequently agreed to a reduction of three points. If this were applied to the industry-wide average, the norm would be 38 per cent, and the plan would work as follows. If total shipments for a given month were $70,000, and inventory change was plus $30,000, total production value would be $100,000 for that month. The "normal" payroll would then be calculated at 38 per cent, or $38,000. If the actual payroll were only $35,000, the difference of $3000 would go to the workers as their bonus.

Several important points are to be noted regarding this approach. First, labor gets *all* of the laborsaving; management's profit from the plan is derived from increased sales with no corresponding increase in total "burden" (i.e., overhead and labor costs). Second—and absolutely basic to the Scanlon system—the bonus is given to all the workers and not just to those individuals who made productivity suggestions. At Market Forge it goes to every person in the business, including Leo M. Beckwith, the owner—and Mr. Scanlon [preferred] this setup. At Lapointe, however, it goes to all except the fourteen top executives, who have a bonus system of their own, based on sales. Lapointe distributes the Scanlon bonus to every individual every month, as a calculated percentage of his basic rate—that is, his hourly, weekly, or monthly pay.

Mr. Scanlon [believed] that the broadest and most meaningful participation requires a union—in the two or three instances where he has proceeded without one there have been delays and difficulties that a union would have helped to untangle. A firm distinction is made, however, between ordinary union affairs and the productivity affairs; grievances, for example, are handled through the grievance committee and are never discussed in the union-management productivity committees. Preferably, the original suggestion to try the plan should come from the union (as at Lapointe); but if it comes from management, the consent of the union must certainly be obtained, together with the approval of the regional representative. In many instances the plan rests on a simple "memorandum of agreement"; at Lapointe it is actually part of the collective-bargaining contract.

Thus the basic theory is that labor should profit from laborsavings, while the company profits from a better use of its assets (for example, lower unit costs). And in order to maintain this dynamic balance at the original point agreed upon, it is provided that changes can be made in the formula to compensate for changed conditions on either side. Thus, some weeks after the plan actually went into effect, management decided to cut prices by 10 per cent on about half the products. Since this would result in a decrease in production value from a nonlabor source, about three points had to be *added* to labor's norm. This would bring our average norm for the industry back to 41 per cent. If management were to raise prices, the opposite adjustment would have to be made.

If a further general rise in wages were to occur, the union at Lapointe would insist that the workers get it in their wage rates; one of Mr. Scanlon's cardinal principles is that a productivity bonus must not be used as a substitute for a wage increase. But again, in order to maintain the dynamic balance, such a change in the wage level, since it would be an additional labor cost, would require a revision of the norm, here, too, upward. The change can be avoided in only two ways: (1) management may pass the increase along in the form of increased prices, in which event the labor ratio to sales will remain the same; or (2) consideration for the company's competitive position may induce labor to absorb part or all of the increase by agreeing to let the ratio stand as it was. Thus at Lapointe the union and the company undertook to eliminate basic wage inequities, and this resulted in a sizable increase in payroll. Since, however, this cost could not be passed along in prices and still keep the business at a good volume, labor consented to the maintenance of the original norm (41 per cent by our hypothetical figure), instead of insisting on a larger share of the sales dollar. In effect, therefore, the increase in payroll cost came out of increased productivity; and since prices did not go up, the customers of Lapointe were the chief beneficiaries of the difference. This benefit to the customers comes back, in turn, to the company in the form of more secure jobs and profits.

On the other hand, there is built into the agreement a provision that where management makes an investment that will raise labor productivity, without any increased work on the part of the labor force, such investment may entail a recalculation of labor's norm, this time downward. Lapointe has, in fact, invested in about forty major pieces of equipment in the past year. It is impossible to tell how much of this is actually new investment and how much is in reality replacement, though the total would run to six figures. Nevertheless, management feels that this investment is to some extent a fair exchange for labor's extra rise in productivity and has not therefore exercised this provision of the agreement.

All this is collective bargaining of a high order, brought about by the participation principle. The entire factory competes, from the ground up. Because management sees its best hope in the cooperation of the workers, it decides to forgo claims that it would otherwise exact. And because the workers know the company's competitive problem in detail, their bargaining for labor's share is oriented to that problem.

One more provision was needed at Lapointe to put the plan in balance. Three times in the first two years the productivity curve has dipped below the norm—that is, labor costs were *greater* than our hypothetical average of 41 per cent. The company had paid out bonuses for the gains; who was to reimburse it for the losses? Owing to the extraordinary understanding that is developed by participation, the men were quick to see the injustice that was being worked on the company, and even though the contract contained no such provision, the union voluntarily agreed to an adjustment. The final arrangement was that the company should hold back half of the first 15 per cent of each month's bonus to take care of possible months when the payroll was greater than labor's norm. This amount is kept in a reserve fund, and whatever is left is distributed at the end of each year.

The reserve has had a salutary effect. It gives management a reasonable protection against temporary but unforeseeable slumps. On the other hand, it gives the workers a better perspective on the business. The desire to protect the reserve gives them the same dread of red ink that management has.

Implementation of the Formula

The increased productivity of the shop under the Scanlon system is not achieved by a "speed-up" in the ordinary sense of the word. Possibly the men work harder, and certainly they work more steadily, but the rise in efficiency is brought about chiefly by suggestions as to how time and effort can be saved. These suggestions are handled by shop committees, called "production committees," whose members are always on the job and easily accessible. They are empowered to put any suggestion into effect that does not involve some other department or a substantial outlay of money. Over the production committees there sits the screening committee, composed of representatives of management and labor from the various departments, which rules on suggestions of wider scope. Each suggestion is carefully tagged with the name of the person making it; if it is accepted, some member of the committee is specifically assigned the job of following it up; if rejected, someone is instructed to make a thorough explanation to the worker. At Lapointe the screening committee has received 513 suggestions in twenty-four months. Of these, 380 have been accepted, 28 started, 32 are pending, and 65 have been rejected.

Employers who have installed a casual "suggestion box" system in their plants can have little idea of the kind of thing that goes on in a Scanlon Plan committee. For that matter, the average employer has little conception of the wealth of imagination and ingenuity lying untapped in the heads of the workmen. Under conventional management such ideas are blocked by a number of factors. A worker who has an idea may be given no incentive to suggest it. But even if there is an incentive, he may decide to withhold it, rather than incur the enmity or jealousy of his fellow workers, and especially of his foreman, who may construe the idea as a criticism of his own management. The individual is frustrated; and, moreover, since he can see how a saving could be made, and since management obviously does not see it, his respect for management declines. Add to this the fact that his communications with management are virtually nil. He has no idea of company problems, and hence no idea of why some moves are made that seem to him (and may in fact be) very stupid.

All this is fertile ground for the kind of animosity that has grown up in some labor circles against what the managers advocate as "free enterprise." Indeed, a number of workers at Lapointe, who feel that they can now talk with freedom, admit that in the old pre-Plan days they never associated themselves or their jobs with the profits of the company and maybe even got a little kick when they heard that the top floor was using red ink.

If one steps from that kind of shop, which often exists even under what is ordinarily called "good" management, and takes one's seat as an observer at a Scanlon Plan screening committee, one passes, with Alice, through the looking glass and into an entirely different world. Like a crack out of a gun the meeting opens with an announcement of the figures for the past month. There follows a roundup by management of the current situation of the company. Then the suggestions are read out, one by one, and debated. A lot of criticism is generated and is of necessity accepted, since it is all directed to the same end—a better profit. Sometimes the workers throw the book at management, sometimes management points out where the shop has fallen down. Engineers argue against machine-tool operators, foremen attack the engineers for unrealistic blueprints, someone demands better maintenance, management points out that more maintenance means bigger labor costs. In the process of this debate, almost every aspect of the business comes up for discussion—sales problems, competitors, orders, bids, spoilage, the business outlook, quality of materials, customers' foibles, management difficulties, etc. The result is a dynamic, working unity, which grows out of the bargaining table and yet wholly transcends it. The sudden realization dawns that here at Lapointe *collective bargaining has come of age.*

The meetings are not recorded verbatim. But minutes are distributed to everyone in the plant, and the important points in the debate are carried by the committeemen back into the shop, where they become the subject of further discussion—at the lunch hour, in the evening, or even at the union meeting. The result is that everyone at Lapointe knows the business and takes pride in his particular contribution.

Company Benefits

The extraordinary results of this formula, implemented by the intimate labor-management committees, could make a long and fascinating tale. For our present purposes it will be necessary to concentrate on the most important.

First of all, the Plan has resulted in a good return to the owners. Since Lapointe does not publish its profit figures it is impossible to be precise about this.[2] The profits at Lapointe have not been so spectacular as those at Adamson—indeed it is probable that during the first year of the Plan the company made hardly any profit at all. This goes back to the nature of the machine-tool industry, which has been in something of a slump ever since the war. It is commonly accepted in the industry that Lapointe has been gaining an increasingly large percentage of the business ever since the Plan was inaugurated. During 1948 great strides were made at Lapointe in its ability to compete, which may not have shown up immediately in the profit and loss statement. In 1949 the results have been much more tangible; in contrast to much of the industry the company is now operating at a good profit.

All of this improvement cannot be attributed to the productivity plan. Lapointe has a sharp-eyed management that has been quick to follow up new leads in the hitherto obscure broaching business. It has been rewarded by the fact that modern engineering is finding new uses for broaching—for instance, machine-gun barrels, which were formerly rifled at the rate of one an hour, can now be broached at the rate of sixty an hour. Moreover, an entirely new business is opening up through the fact that certain parts of jet engines cannot be efficiently manufactured except by broaching. These are long-range gains attributable to factors other than labor.

However, management and labor are now cooperating so effectively at

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[2] The Kiplinger magazine . . . published figures on Lapointe, but many were inaccurate and were denied by the company.

Lapointe that it is impossible to tell where the contributions of one ends and that of the other begins. Certain intangible benefits have accrued from this teamwork that affect the company's whole operation. For example, there has been a vast improvement in deliveries. Formerly delivery on ordinary broaches had been from three to five weeks and was often late. Now delivery can be made in from one to three weeks and is usually on time. This has become a great selling point for the company.

A second advantage is the reduction in complaints from spoilage and imperfect workmanship. Lapointe's policy is to take back any unsatisfactory product and fix it without extra cost. Under the Scanlon Plan this means *a loss to the workers as well as to the company*, and as a result great care is taken all along the line. The workers, indeed, get very excited about the big jobs. In one instance, when a new machine for a big automobile manufacturer was being tried out in the Lapointe plant, several of the union committee left their own jobs and gathered around to see whether the automotive manufacturer's engineers were duly impressed. While losses from customer complaints probably never amounted to as much as 1 per cent of the business, the intangible result of satisfied customers willing to reorder is a real one, for which management can thank its own foresight in installing a plan that gives the workers an interest in their product.

Moreover, the problem of instructing younger workers has been greatly advanced. Formerly, under the piecework incentive system, a highly skilled workman was reluctant to show a younger man the tricks of his trade. But today the older workers are eager to teach their skills, in order to raise shop productivity. The most dramatic example at Lapointe was that of Robert Juliani, the best and most experienced form grinder, who made $3.57 an hour under the old piecework system. Formerly Mr. Juliani was given no incentive to share his knowledge and skill, but after the plan he reorganized his work, took on two helpers, and taught them many of his ways of doing things. It is estimated that his increased efficiency is in the neighborhood of 300 per cent.

The plan, indeed, has completely solved the problem of "controlled production"—that is, the policy, common to almost all labor, of holding back so that management will never know how fast a man really can work. The very first day it was installed a toolmaker, who had been producing twenty units in eight hours, produced sixty-two units. A surface grinder, whose average weekly earnings had been $76 on piecework, turned out $184 worth of work in four days. And so forth, through innumerable examples.

Labor Benefits

On labor's side the benefits have been equally great. The average pay at Lapointe is in line with basic steel for the region, and for two years the workers have taken home an average bonus of 18 per cent over and above this. The bonus has, naturally, varied widely, ranging from zero to 39 per cent in June, 1949. Even better results are expected in 1950.

But the workers, like management, have derived many intangible benefits that cannot be measured in dollars and cents. They seem to enjoy working together and sharing the good and bad times. As one of them said, "Formerly everyone was on his own. Now we all work for each other." Innumerable versions of this observation can be picked up around the plant. One can spend little time here without reflecting that one of the weaknesses of conventional management is its almost exclusive emphasis on the money incentive. For the money incentive cannot satisfy the many demands of human nature—and this goes for management as well as for labor. Other incentives are needed if a man is to lead a healthy and happy life. Among these, two are of the utmost importance. One has to do with one's self—a feeling of accomplishment, a recognition of one's own abilities. This is provided for in the Scanlon Plan through the suggestion system, because a man who makes a good suggestion gets a profound satisfaction out of it; he carries the story home to his wife; he is admired and thanked by his associates. But the Scanlon Plan goes further, in that the reward for such suggestions does not go to the individual alone but to the entire shop. On the one hand, this eliminates jealousy; on the other, it opens up for the ordinary worker a kind of social or community incentive to which he eagerly responds. Cynics to the contrary, men do get a kick out of helping their fellow men; and this is demonstrated at Lapointe, where an atmosphere prevails in the shop that cannot possibly be duplicated under the selfish piecework system.

Yet another intangible advantage that the workers have derived is a strengthening of the union. If any employer becomes interested in this plan as a means of undermining the union, he had better skip it. Mature collective bargaining that has reached the evolutionary stage here described has precisely the opposite result. When the Plan was installed, union membership at Lapointe was about 70 per cent of the working force, exclusive of the office workers, who were not organized. Today all but three or four employees are union members, and the office workers have joined in a body. Interest in the union is keen. The advantage of this from the employer's point of view is that union meetings, instead of being dominated by a few malcontents, are heavily attended; and often enough most of the discussion is devoted to company affairs and how productivity can be increased. The union president, energetic and imaginative Fred Lesieur, who has succeeded Mr. Ali, is enthusiastic about the Plan. The result of all this is that grievances have almost disappeared—only three have been processed in twenty-four months, and none of them has had to go to arbitration.

One of the greatest advantages of this kind of collective bargaining, from the worker's point of view, is the knowledge that it gives him of the business. When a slump is coming, he knows it. He is even given a chance to combat it, in the sense that if he can devise a cheaper way of turning out his product, perhaps the company will be able to take business away from somebody else. In a number of instances the Lapointe workers have actually done this, the most spectacular example being that of an order from a big automotive concern in December, 1948. The workers had been pressing management to accept orders even at the break-even point so as to tide over a bad period. Mr. Prindiville, who sometimes sits in on the screening-committee meetings, had given in to the pressure some months previously to the extent of taking an order from this firm for 100 broaches at $83 per broach. But Lapointe had lost 10 per cent on the deal, and Mr. Prindiville now put his foot down. If this business was to be taken again the price would have to be raised. In view of new competition, it meant that Lapointe almost certainly would not get the business—and at a time when work was scarce.

The gloomy gathering that listened to Mr. Prindiville's pronouncement was then electrified by a question from Jimmie McQuade, skilled grinder and one of the most outspoken members of the screening committee. Who says we can't make those broaches at that price for a profit? Mr. McQuade wanted to know. If you'd give the men in the shop a chance to go over the blueprints before production starts and to help plan the job, there are lots of ways of cutting costs without cutting quality. The idea grew, and the next day the suggestion ran around the shop like wildfire. The order was taken at the old price, this time with a *profit* of 10 per cent—a total gain in efficiency of 20 per cent.

The truth is that the Scanlon Plan has generated a competitive spirit throughout the factory: one hears as much about competition from the workers as from management itself. If there is a question of struggling for existence the whole company struggles collectively, and all the brains available are focused on the fight. The worker is no longer a pawn in a game he does not understand. He is a player. He enjoys it. And his contribution is worth money to all concerned.

The Team at Work

The effectiveness of such teamwork becomes especially apparent in the crises. Lapointe has been through three critical periods since the Plan was installed, and it has lifted itself out of them principally because the Plan creates an overwhelming incentive to cooperate.

The first crisis occurred in the fourth month. Mr. Scanlon had warned management that output would greatly increase and that they had better begin hustling up some new orders. But management had a normal backlog, and inasmuch as it was having trouble with deliveries it did not dare put on any extra sales pressure. The very first month, however, productivity shot up to 133 per cent (100 equals the predetermined "norm" already defined); the second month registered 128 per cent and the third 121 per cent. The result was that the company's backlog melted away. Management, of course, sprang to action as soon as the danger was realized. Telegrams and telephone calls poured out of Hudson. The salesmen were lashed to activity. Though himself a production man, Vice President Dowd—and even several engineers—took to the road. But broaches and broaching machines are technical tools that sometimes require weeks of designing before production can begin. Consequently the new orders did not give much immediate help, and the next three months were bad; the company ran a loss and the workers got no bonus.

Yet, as it turned out, the strength of the Plan was best demonstrated when things went bad. The workers had had three months of participation; they looked forward to bonuses in the future; and they liked the Plan because it gave them a *chance*—a chance to fight, a chance to pit their skills against other enterprises. Consequently, despite the setback, sentiment among them was overwhelming to continue the Plan, and suggestions kept pouring in for improvements. By June, 1948, a small bonus (4.7 per cent) was earned.

But then there was new trouble. The usual practice of the plant was to shut down for vacations for two weeks in July. Big new orders had come in, but these had to pass through the engineering department for designing, and when the engineers were on vacation no designing would be done. Would anybody dare to ask the engineers to give up their vacations?—especially in view of the fact that, as is usual in machine shops, there was continuous bickering between the engineers and the machine operators, who were inclined to criticize the drawings as unrealistic. A delegation from the union approached Vice President Dowd, who said that he would put it up to the men themselves. When he went to the men, however, he found that agreement had already been reached at the workers' level—the engineers had sacrificed their vacations. They worked hard during July in an otherwise empty plant, and by August drawings were pouring out of the drafting room. Productivity soared again, yielding a bonus of 25 per cent for September and 19 per cent for October. A better example of community incentive could hardly be found.

Still another difficulty then arose. The problem was to devise a machine capable of broaching certain parts of a jet airplane engine. Everybody had said the parts in question could not be broached, but the Lapointe engineers insisted they could be, providing a new machine was developed. The problem centered around a very hard steel, close to the limit for cutting tools, and the company's efforts to solve it resulted in many a setback. Labor watches every job at Lapointe, and the men became impatient when they saw so much work being done on which there would be no shipping dollars. But management went back to the screening committee again and again and said in effect, "Bear with us. This is experimental stuff. If we can get it right, we're in." So the screening committee went along. Then at last the bugs were out, production began, and everybody went to town. The monthly productivity curve shot up, from a dismal low of 71 per cent in December, 1948 (in the middle of the experimental work), to 119, 138, 140, 145, 150, and finally, in the twentieth month of the plan, to 161 per cent.

These three incidents provide three dramatic examples of teamwork. In the first, the workers held on despite an unexpected discouragement. In the second, the engineers came to the rescue of all concerned. In the third, management exercised its proper function with great intelligence, by insisting that temporary losses be sustained in order to grasp a future profit. If this experimental work had failed, a certain field of sales would have been closed to Lapointe. As it is, the firm got in on the ground floor of a new and growing business, and all concerned will profit from that achievement.

Will It Work for You?

Many objections will be raised to the Scanlon Plan by those who have never seen it in operation. But perhaps the least fruitful objection of all is the one most commonly encountered: "This plan may work at Lapointe—or wherever—but that is because of special, perhaps accidental, circumstances. *My* plant is different."

Of course, everybody's plant *is* different. Every union is different also. For this very reason, Mr. Scanlon [refused] to crystallize his work into a formula. He [relied] on certain principles fundamental to human nature; and he [adapted] these in almost infinite ways to the particular problems of each particular company. [His plan] has now met with success in varying degrees, in more than fifty enterprises in several different industries, of many different sizes, under many different circumstances; where the original labor relations were good and where they were bad; where profits were good and where they were nonexistent; where labor productivity was easy to measure and where it was virtually impossible; among skilled workers and unskilled workers. There are, of course, shops where this plan would not work. But the burden of the evidence is accumulating that those in which it will not work are the *exceptions*.

Yet there are two prerequisites to the Scanlon Plan, and where they do not exist time would be wasted in trying to install it. One is that the union leadership must be intelligent. This does not mean that the union should be acquiescent: on the contrary, it may be quite aggressive. But real intelligence is needed to bargain at a participation level, which involves an understanding of such things as competition, competitive pricing, profitability, and many other factors that never enter into collective bargaining at the lower level. This prerequisite to Scanlon Plan success is provided at Lapointe by Fred Lesieur, the new union president, who, as a good union man, considers it his *responsibility* to have an intelligent grasp of the productivity side of the business. The other union officers share this responsibility.

Second, and even more important, there must be someone in top management who is vitally interested and *who is able to stand the gaff.* A management that wants to stand off and look down its nose at the workers cannot operate a Scanlon Plan. Nor is it possible to turn this vital area of the business over to a vice president in charge of industrial relations. Someone who actually runs the company or the plant—the president or his executive representative—must be a regular member of the screening committee (he need not be chairman); and this person must be willing to enter into any kind of debate and to accept in a fair and impartial manner any criticism hurled at his own management. He need not worry about his dignity. The men will invest him with the dignity he deserves—no more, but no less.

It is precisely in this respect that Lapointe has been so fortunate. Lapointe has in John Prindiville a man of open mind, who believes that the incentives of enterprise should reach down, through management, to the shop floor. And it has in Ed Dowd a man who became the Plan's prime mover, utterly dedicated to its goals. Mr. Dowd is not afraid of criticism—and is not afraid to give it. The men know he is sincere in his efforts to make the Plan work, and they consequently trust him. Besides, he sets quite a pace. When the argument gets hot, he takes off his coat, and everyone interprets this as permission to do likewise. Comfortably in his shirt sleeves, Ed Dowd pitches into the suggestions, throws upon each of them the light of his enormous knowledge of the business, tosses them back to the committee, and finally designates some individual to "follow it through." When there is a tough one involving important company policy, Ed Dowd takes it himself.

If such men can be found—an intelligent union leader and a forthright management leader—the Scanlon principles can be applied virtually anywhere. And the way is then opened up to a new and creative area of industrial relations—the area of mutual interests. In the process of entering upon this area, and of consolidating it, *everyone* in the shop, high or low, joins the enterprise system.

iii. The Scanlon Plan through a Psychologist's Eyes

From Douglas McGregor, "The Scanlon Plan through a Psychologist's Eyes," in Frederick Lesieur (ed.), *The Scanlon Plan*, Technology Press, MIT, Cambridge, Mass., and John Wiley & Sons, Inc., New York, 1958, pp. 89–100.

Although [Scanlon] was anything but a theoretician and although he was only casually familiar with the research findings of the social sciences, the Plan he conceived fulfills to a remarkable degree the requirements for effective organized human effort that have been highlighted by such research. In addition, the actual experiences of Scanlon Plan companies provide significant verification of the predictions the social scientist makes on theoretical grounds.

The Plan implements Scanlon's underlying belief by establishing three broad conditions within which it becomes possible and natural for all members of the firm to collaborate in contributing to its economic effectiveness. These conditions are:

1. A formally established "area of collaboration" and machinery (production and screening committees) for coordinating such collaborative efforts throughout the whole organization. This is accomplished without undermining collective bargaining or weakening the local union.
2. A meaningful, realistic, common objective (the "ratio") in terms of which such collaborative efforts can be objectively measured.
3. A psychologically adequate system of rewards (noneconomic as well as economic) for a wide range of contributions to the effectiveness of the enterprise. (Traditional incentive wages, profit sharing, and suggestions system awards are quite inadequate in terms of modern psychological theory.)

As a consequence of establishing these three conditions, the employees and the managements of Scanlon Plan companies literally discover a new way of life. The process is not easy; some of the learning is rough indeed. There is little of a sentimental sweetness-and-light atmosphere, but there develops a mutual respect which cuts across even the most violent disagreements. The new relationship permeates in surprising but meaningful ways into every corner of the organization. It is some of these consequences and their relation to social-science theory and findings that I would like to examine.

Scientific Management and Human Capabilities

Many research studies have pointed out that, however persuasive the *logic* of "scientific management" may be, the consequences of its application are often contrary to expectation.[1] Informal but effective collusion to defeat managerial purposes takes many forms, and it is widespread. Less recognized, but perhaps more important than these consequences, is the failure of this approach to make effective use of the potentialities of people. Treating the worker as though he were, in Drucker's words, a "glorified machine tool"[2] is a shameful waste of the very characteristics which distinguish people from machines.

Despite protests to the contrary, the approach of scientific management has been to treat the worker as a "hand" rather than a human being. The consequences of so doing have been attributed to the "natural" cussedness of workers and explained as the price of technological efficiency. Pleasant working surroundings and fringe benefits have been used to alleviate the negative aspects of assembly-line jobs. Fancy communications programs and Madison Avenue sales gimmicks have been used to persuade the worker of the vital importance of his tiny contribution to the enterprise. These are understandable but largely ineffective palliatives. However, work simplification and all the other paraphernalia of the industrial engineer—consistent with a view of the worker as a glorified machine tool—remain the commonly accepted way to utilize human effort in industry.

Scanlon knew better. He knew that what Drucker calls "industrial citizenship"[3] is perfectly possible even in the mass-production setting, provided management will recognize that workers have brains and ingenuity as well as muscles. The Scanlon Plan creates the necessary conditions for this discovery. Once these conditions are established, people collaborate because it is to their interest to do so. They don't need to be made to "feel" important; they *are* important and they know it.

The most far-reaching consequence of this creation of genuine industrial citizenship is the virtual elimination of what Argyris calls the sense of "psychological failure" created by the traditional approach of scientific management. Among other things, the notion of the "nonproductive" worker, and the "burden" concept of staff and administrative employees go out the window. Productivity, under the Scanlon Plan, is not confined to direct production workers, nor is the line organization the only part of the enterprise that is seen as carrying its own weight. Productivity is measured by reduction of the labor bill, and *everyone* can contribute to this objective.

Improvement of the ratio, by every means, is everybody's business. The individual's contribution is not limited to doing "a fair day's work." The janitor and the stenographer, as well as the engineer and the manager, can, and often do, exercise human ingenuity in developing improvements entirely outside the limits of their own job descriptions. The area for collaboration covers anything that will contribute to the effectiveness of the enterprise.

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[1] Chris Argyris, *Personality and Organization*, New York: Harper, 1957. Chapters IV and V summarize the data succinctly.

[2] Peter Drucker, *The Practice of Management*, New York: Harper, 1954, pp. 280 ff.

[3] Peter Drucker, *The New Society*, New York: Harper, 1949, pp. 151 ff.

The challenging opportunities that are inherent in every industrial organization for people to assume responsibility, achieve status, acquire new skills, learn, develop, exercise creativity become apparent once this area of collaboration is carved out. The idea that workers are paid to do what they are told and management is paid to tell them not only prevents effective collaboration but automatically creates the feeling of psychological failure. It leads either to indifferent passivity or to active hostility. Genuine participation in problem solving removes the causes of these common reactions.

The Task of Management

It should not be supposed that management loses its responsibility to manage under a Scanlon Plan. Much to the contrary. One of the happier consequences is that the foreman ceases to occupy the impossible role that has been his in recent years and becomes a manager in the real sense of the term. He is no longer caught in the problem of divided loyalties and conflicting pressures. He is no longer the pawn of a variety of staff groups who "control" him to death under the label of serving him. He ceases to be a paper shuffler, an ineffective disciplinarian, a "master and victim of doubletalk,"[4] and becomes a manager willy-nilly. Sometimes the pressures that bring about this transformation are painful in the extreme. However, most supervisors come to relish their new role.

Further up the line there is considerably less tilting with the windmill of prerogatives and more genuine concern with managing the enterprise. One of the interesting phenomena among management people in Scanlon Plan companies is their inability to comprehend the questions that are frequently asked of them concerning their freedom to manage. Authority in the sense of the right to be arbitrary, to force subordinates to do their bidding, ceases to be a meaningful idea because the collaborative relationship almost eliminates the necessity for this kind of order giving.

The management task in Scanlon Plan companies becomes one of genuine leadership. The manager who is primarily a power seeker and a protector of management's right to be arbitrary finds little satisfaction in such a situation. The pattern of managerial behavior which tends to emerge is remarkably close to that of the "democratic" leader in the classic Lewin and Lippitt research.[5] However, this term "democratic" does not mean abdication; it does not imply that "everyone decides everything." Its essence is that it makes effective use of human resources through participation; it provides general rather than close supervision; it is "employee-centered" [6]; it encourages responsible behavior and tough-minded self-control rather than reliance on external authority.

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[4] Fritz Roethlisberger, "The Foreman: Master and Victim of Doubletalk," *Harvard Business Review*, Vol. 23, No. 3, Spring, 1945, pp. 283–298.

As mentioned above, disagreements flourish in Scanlon Plan companies. Management has the responsibility and exercises the authority in their resolution. The difference is that people usually disagree about the best way to do the job or to reduce costs or to improve the profit margin rather than about whose rights are what or what legalistic interpretation should be put on a work rule. This is a big difference.

The Scanlon Plan typifies Drucker's "management by objectives and self-control." General (as opposed to close) supervision and wide delegation evolve naturally as management discovers that it is no longer necessary to force people to do what needs to be done. It becomes possible to deal with people as mature adults rather than as children and thus to avoid much of the conflict between organizational requirements and the needs of the human personality which Argyris has so well delineated.[7]

Cooperation and Competition

The psychological significance of all of this is that the Scanlon Plan "fits together" the purposes of organization with the natural human tendency to collaborate when collaboration is the sensible way to do things. Industrial organizations are complex *interdependent* human entities. Unless the many related functions are smoothly interlocked, unless people are constantly adjusting to each other in terms of common objectives, organizations cannot operate effectively.

Emphasis on individual competition, on narrow job responsibilities, and antagonism toward the natural tendency of humans to form groups characterize much of present-day managerial practice. This emphasis is 180 degrees out of phase with the need for collaboration in a complex system of interdependence.

The Scanlon Plan sets a meaningful common objective and creates the necessary conditions to bring practice and organizational need into phase. Instead of lip service to "teamwork" within a system which stacks the cards against it, the Scanlon Plan makes teamwork the natural way of life. And then it becomes no longer necessary to preach about its value!

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[5] Kurt Lewin, Ronald Lippitt, and Ralph K. White, "Patterns of Aggressive Behavior in Experimentally Created Social Climates," *Journal of Social Psychology*, Vol. X, 1939, pp. 271–299.

[6] Rensis Likert, "Motivational Dimensions of Administration," *America's Manpower Crisis*, Chicago: Public Administration Service, 1956.

[7] Chris Argyris, *op. cit.*

Competitive motivations—also natural to humans—are not ignored either. However, instead of competing with fellow workers, or saying, "To hell with the other department (or the other shift); I'm paid to do my job, not to worry about them," the competition is with other companies in the industry. In a capitalist economy what could be more natural?

Resistance to Change

A fair amount of research has pointed up the fact that resistance to change is a reaction primarily to certain methods of instituting change rather than an inherent human characteristic.[8] Leo Moore and Herbert Goodwin of the M.I.T. School of Industrial Management have coined the term "improvement management" to describe a way of gaining some of the benefits of scientific management without producing resistance to change.[9] The Scanlon Plan minimizes such resistance because it involves people in the process of creating change rather than imposing it on them. Improvement management is the Scanlon way of life because everyone is interested in improving the ratio.

Significant examples of worker-generated change in the organization of work are common in Scanlon Plan companies. Ironically, these are frequently changes that management tried unsuccessfully to introduce in pre-Scanlon days. Resistance becomes instead active instigation. In fact, the Scanlon Plan company experience with the change process is one of the most clear-cut examples of the way in which the research-based predictions of social science are fulfilled in practice.[10]

It is perhaps needless to point out that restriction of output, featherbedding, collusion to fudge production records, and all the other ingenious group methods of defeating the managerial purposes of traditional incentive plans disappear completely in Scanlon Plan companies. Again, this is exactly what the social scientist would predict on the basis of his research into the causes of these phenomena.[11]

Human Motivation

Examination of modern theories of motivation points up further Scanlon's insight into human behavior. The Scanlon Plan production and screening committees, as well as the whole management-employee relationship which develops, provide ideal means for satisfying ego and self-actualization needs which are typically frustrated under the conditions of present-day industrial employment.[12]

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[8] Alvin Zander, "Resistance to Change: Its Analysis and Prevention," *Advanced Management*, Vol. 15, No. 1, January, 1950, pp. 9–11.

[9] Leo Moore, "Too Much Management, Too Little Change," *Harvard Business Review*, Vol. 34, No. 1, January–February, 1956, pp. 41–48.

[10] See, for example: Lester Coch and John R. P. French, Jr., "Overcoming Resistance to Change," *Human Relations*, Vol. I, 1948, pp. 512–532; Kurt Lewin, "Group Decision and Social Change," *Readings in Social Psychology*, rev. ed., New York: Henry Holt, 1952, pp. 459–473; A. T. M. Wilson, "Some Contrasting Socio-Technical Production Systems," *The Manager*, December, 1955.

[11] William Foote Whyte, *Money and Motivation*, New York: Harper, 1955.

There is no undervaluation of economic motives either. However, one happy consequence of the Scanlon Plan is the minimization of conflict over the workers' share of the proceeds of enterprise. The ratio is determined from accounting data, and even in unionized companies there is no instance on record of an impasse over this issue! [13]

The economic rewards of the Scanlon Plan are fully consistent with present-day psychological knowledge. First, they are related to factors in the work situation which are controllable by employees. This is in contrast to most profit-sharing plans. Under the latter workers are rewarded in a fashion which is only remotely connected to their direct contribution. (I know of one profit-sharing plan where the profits which were shared for several years resulted primarily from the speculation of the treasurer of the company in the raw-materials market!)

Second, the payoff is within a sensible time span. It is well established that rewards become less effective the more remote in time they are from the behavior which is being rewarded. An annual payoff (typical under profit sharing) is too remote to be of much use as a motivator. The monthly payoff under the Scanlon Plan is meaningfully related in time to the behavior which affects the ratio.

Third, the plant-wide nature of the bonus is realistic in terms of the common objectives of the members of the enterprise. It does not eliminate individual differences in wage rates related to job responsibilities, but it creates the proper perception of "sharing" in a common endeavor.

Fourth, the bonus is paid for *all* contributions to the effectiveness of the enterprise rather than for the narrow contribution of output per man-hour which is common under conventional incentive plans. There are no problems in relating pay to fancy (and largely unrealistic) "standards" for measuring individual performance, particularly for maintenance, clerical, and other service jobs. Moreover, there is no longer any incentive to defeat the time-study engineer or to hide jigs and fixtures which have been invented to "beat the standard" or to establish collusive relations with tool-crib clerks, timekeepers, inspectors, and others in order to "make out." [14]

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[12] Abraham Maslow, *Motivation and Personality,* New York: Harper, 1954, especially Chapters 4, 5, 8; Douglas McGregor, "The Human Side of Enterprise," *Management Review,* November, 1957, pp. 22–28; E. Wight Bakke, *The Unemployed Worker,* New Haven: Yale University Press, 1940; Robert W. White, *Lives in Progress,* New York: Dryden Press, 1952.

[13] Scanlon was insistent—and wisely so—that the Plan offer management no escape from meeting the standards of wage levels and other conditions of employment established generally by collective bargaining. To use it in this fashion would be the surest way to undermine the union's acceptance of the philosophy of collaboration. The Scanlon Plan would quickly be seen as a device to negate the legitimate gains of the labor movement.

Finally, the payoff reflects the success of the enterprise in understandable terms. There is no necessity for interpreting the elaborate formulas of the industrial engineers (which workers are quite able to do, by the way), or for fathoming the formalized and often misleading gobbledygook of the balance sheet.

Mention of the balance sheet leads to one other economic point I would emphasize: the education for all participants in the economics of enterprise. American management has spent many millions of dollars in attempts to provide economic education to workers. The results have not been measured, but one may be permitted a certain skepticism.[15]

The Scanlon Plan, however, provides such education in the most direct fashion: through day-by-day involvement in the problems of the enterprise. A casual conversation with Scanlon Plan company employees often reveals an understanding of our economic system which is uncommon even among college graduates. And this fundamental and important educative process costs not one cent! It requires no films or brochures or discussion groups or lecturers. It is obtained in the normal course of daily life by direct, firsthand experience. Scanlon Plan company employees are believers in capitalism and they know *why* they are!

Staff-Line Conflict

Friction between workers and lower levels of supervision on the one hand and staff departments such as industrial engineering, accounting, personnel, inspection, inventory control, purchasing, and research and development on the other hand is widespread in industry today, and it is a good deal more costly than management usually recognizes. Research studies and reports of participant observers have provided substantial evidence of these phenomena.[16]

A major cause of these frictions is the fact that staff departments are placed in the position of imposing their standards, their plans and procedures, their "expertness" on the line. This is a fact quite generally despite textbook assertions that the staff functions are those of service, advice, and counsel. The staff engineer tells the worker to "follow the blueprint" even when (as happens all too often) the worker's knowledge of his tools and materials tells him that this is foolish or impossible. A substantial amount of paper work by the supervisor is summarized or scrutinized by the accounting department and turned over to others higher in the organization to be used frequently in a disciplinary manner ("Your variances are out of line," or "You have overrun your budget," or "You made an unauthorized expenditure").

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[14] William Foote Whyte, *op. cit.*, particularly Chapter 7.

[15] William H. Whyte, *Is Anybody Listening?* New York: Simon & Schuster, 1952; Douglas Williams in *Management Education for Itself and Its Employees*, New York: A.M.A., 1954, Part 4.

[16] William Foote Whyte, *op. cit.*; Chris Argyris, "Human Problems with Budgets," *Harvard Business Review*, Vol. 31, No. 1, January–February, 1953, pp. 97–110; Charles A. Myers and John G. Turnbull, "Line and Staff in Industrial Relations," *Harvard Business Review*, Vol. 34, No. 4, July–August, 1956, pp. 113–124; and F. J. Roethlisberger and William J. Dickson, *Management and the Worker*, Cambridge, Mass.: Harvard University Press, 1939, Part IV.

The simple psychological fact is that external controls of this kind engender hostility and lead to the exercise of a substantial degree of ingenuity directed solely toward defeating the purposes of those who have instigated the controls. This is the exact opposite of management's desire; it is the antithesis of collaboration. Unfortunately, management at the top is rarely aware of the extensiveness of this internecine warfare, and the staff groups tend to interpret it as evidence of the stupidity or inherent hostility of workers and supervisors. The typical staff reaction is to tighten and elaborate the controls, which of course simply makes matters worse.[17]

The Scanlon Plan, when these groups are included, creates entirely different relations between staff and line. The need for external controls diminishes to the vanishing point as the collaboration toward the common objective of improving the ratio becomes the way of life. The staff groups can help the line in a great many ways if this is what they are set up to do. The line learns to use and to value this help as soon as the staff is relieved of a function which makes them appear to be policemen and spies. Evidence for this fundamental change in relations is to be found readily in Scanlon Plan companies. One nice example was the occasion at the Lapointe Machine Tool Company when the engineers voluntarily postponed their vacations in order to prepare specifications for a new order so that there would be sufficient work to avoid a layoff in the factory.[18]

If the Scanlon Plan accomplished nothing else but to bring about effective collaboration between staff and line it would be a major contribution to organizational effectiveness. But this consequence is simply one of a large number of by-products resulting from a changed way of life. It is, in addition, a convincing demonstration of the well-established psychological fact that self-control is far more effective than externally imposed authority.

[17] See Argyris, "Human Problems with Budgets," *op. cit.*, for a penetrating analysis of this set of problems.

[18] Fred Lesieur tells how the machinists in this same company, during pre-Scanlon days, would receive with glee a set of engineering specifications containing a major error and build the equipment exactly "according to specs" with full knowledge that it would ultimately have to be scrapped!

Conclusion

There are other ramifications of the operation of the Scanlon Plan which fit consistently with the implications of modern social-science findings. However, those discussed above serve to document my initial assertion concerning this consistency. They demonstrate, also, the difference between the usual personnel "program" and a genuine organizational philosophy, an industrial way of life.

No doubt other patterns of relationship will be found which yield results comparable with or superior to the Scanlon Plan. It is probable that the Plan as Scanlon conceived it would be difficult to establish in some kinds of industrial situations even if both management and union desired it. However, I will venture the prediction that we will succeed in increasing our utilization of the human potential in organizational settings only as we succeed in creating conditions which generate a meaningful way of life.

Scanlon's lasting contribution is his recognition—now effectively demonstrated in action—that one cannot successfully tackle this central task of management with gimmicks or procedures or programs. The real task of management is to create conditions which result in genuine collaboration throughout the organization. To create such conditions is to establish a way of life. This is the central conclusion to which the findings of social science are pointing today. And this is the lesson that Joseph Scanlon taught us all.

5. MONEY AND MOTIVATION IN THE AUTOMATIC FACTORY

From J. R. Gass, "Automation and Technological Change in the European Economy: A Research Planning Memorandum," 1957, unpublished.

Much of the technique of scientific management arises from the fact that in non-automatic production systems, the human operator is a major factor governing rate of output and is also a major element in cost. The point of focus of many techniques of scientific management is logically the worker: motion study to improve his working movements and methods; time study to bring order into human variations in performance and, through incentive payment schemes, to stimulate effort. In the highly capitalised, technically integrated, automatic plant (or in plants where one or more of these elements are present to a marked degree), such techniques have little point: the change in cost ratio means that the major savings are to be found elsewhere; technical integration means that the operator no longer controls output; the monitoring function of the operator on automatic plant removes any interest in his manual movements. These changes mean, at least, a changed emphasis in scientific management, and possibly a complete reorientation of it as it has been traditionally understood.

Since maintenance and amortization form a much higher proportion of cost in the highly automatic plant, there must be changes in methods of cost control. Rule of thumb methods of allocative overheads, though adequate for fixing prices, will be grossly misleading if they are used to compare the real cost of alternative methods of production, for the overhead element in cost is no longer marginal. For similar reasons a plant with a high ratio of capital to labour will need different indices of control and efficiency. Indices showing the utilization of machines and the proportion of down-time due to breakdown, lack of work, or other causes, will become much more important than formerly, but the index of output per head will be less important.

An inevitable corollary of automatic production is that the various parts of the plant have to operate as a co-ordinated whole; in a real sense the plant becomes a single *technical system.* In engineering, the system is made up of linked machine tools (including transfer machines) with different operation time cycles, rates of wear, characteristics of breakdown, etc. In chemical processing, the efficiency of the system depends on the physical (dynamic) characteristics of the plant and of the chemical process itself. In both fields, the gains in efficiency are to be found in better understanding of the technical system rather than in any labour savings. In both fields, statistical techniques of a similar kind are required: on the engineering side, most progress with these methods seems to be being made in Russia; in the chemical processing field, a great deal is being done in leading industrial firms in European countries and America. Together, these developments suggest that there is a broad movement away from traditional techniques of work study, towards methods suitable for analysing the relationships in complex technical systems, with a view to optimising their performance.

Although the efficiency of the technical system is likely to be the main focus of management technique in highly automatic and integrated plants, the role of the human operator as a *monitor* will continue to be important. Methods of analysing monitoring skills will need to be devised if the proper balance between the functions of the machine and those of the human operator is to be struck. In monitoring, the perceptual element (taking in and acting on information) is important in skill, and some progress has been made by the experimental psychologists in methods of analysing problems of perception. The outstanding question is whether such laboratory techniques can be developed so as to be applied in the day-to-day practice of management in industry. The need is obvious when one sees the considerable dilemma arising in industries where monitoring operations and manual tasks exist in the same plant. For the manual tasks, highly developed techniques of work study are available; for the perceptual tasks, no way of determining the level of skill and effort—and therefore of payment—exists. Such a situation is bound to lead to intractable problems of wages structure and job analysis.

F. TECHNOLOGY AND CHANGE

In a sense we have been dealing with phenomena of change throughout this part on the problems and promise of the machine age. The novel ways of organizing human work, as introduced by Ford, Taylor, and others, were a revolutionary change; the new machine-man relationship and its unexpected problems for today and tomorrow is another face of technological change. Or again, the new molds into which human organizations have been poured as a result of science and technology are another. Finally, the theory and the methods of rewarding people financially have changed markedly from the early days of the industrial revolution to the present age of automation and nuclear power.

For the most part, however, in the earlier sections we attempted to look at human relations *after* the technological changes had taken place and when something of a new equilibrium had been established. Here we consider change *itself*, which will mean a close look at specific changes before, during, and after their impact, asking such questions as: How can major—and minor—changes be predicted, prepared for, adjusted to? What are the important change problems for industry and for organization in the modern world, and in what direction may solutions be sought?

It is obvious that we cannot begin to review the impact—and the problems—of change in all areas of human activity. As in previous sections we shall focus largely on reactive situations between technology and people in *industry*. It is important to note, however, that change problems in industrial organizations are not too different from change problems in other human organizations. The author, while this book was being written, participated in two separate conferences on adjustment to change, one composed of representatives of major industries, the other of representatives of major government departments, including the Army, Navy, and Air Force. In both conferences, change problems whose origin was technological received serious attention, and as viewed by the administrator they were remarkably similar.

The origins of change in industry are, of course, varied. A depression, a revolution in consumers' preferences, a management replacement, a financial reorganization—any of these factors singly or in combination may bring about drastic changes in the structure of a corporation and be accompanied by a hundred administrative and human problems. But, increasingly, new technologies are the prime movers of change and of the human problems associated with them.

Obviously, changes of some sort are continuous, both in organisms and in organizations, but unless they are of a particular character and dimension, no one pays attention. An illustration is the infinite series of physiological changes which take place in the human organism every twenty-four hours, few of which are noticed unless the individual is in trouble, unless, for example, he breathes hard, turns pale, gets indigestion, or has a heart attack—to name a few *observable* changes.

Similarly, an industrial organization experiences internal changes continuously, but the administrator or union leader takes note as a rule only when they mean trouble. Not only large changes such as those due to widespread technological revolution are important and problem posing; relatively small ones such as the introduction of a more efficient battery of grinders into a machine shop are also important. In this section we shall consider both kinds of change, the large and the small, the technological revolutions that affect many people and the smaller innovations that affect few.

Our first selection is the simple story of the introduction of wheeled vehicles into a settlement of American Indians. This modest case study is suggestive of the many social revolutions that have followed—and will follow—in the wake of new technologies in underdeveloped countries. The reader will find this theme more fully discussed in Part Three.

We begin the topic of large changes with an account by a contemporary reporter of the introduction of the continuous strip mill into the steel industry of the United States (see selection entitled "A Case Study of Technological Unemployment"). In the field of large changes, a dozen other technological revolutions might have been chosen to illustrate massive impact—the reciprocal gas engine, the electric lamp, oil refining, radar, nuclear power—but one advantage in choosing the strip-mill instance is that the whole case was later submitted to congressional investigation with representatives of all parties called upon to testify. This was done in 1940 under the auspices of the Temporary National Economic Commission. The Commission has been justly criticized, the author believes, for being subject to extreme political and other partisan pressures. It succeeded, however, in amassing a storehouse of useful data on the social impact of technological change.[1] If the steel-mill technological revolution was given a post-mortem review of some value after the event, it was not studied by competent observers while it was occurring. Industrial sociology was a new discipline and there were few, if any, social scientists living in "ghost towns." Nor did the impact of the new technology recruit the energies of competent observers or analysts.

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[1] *Hearings before the Temporary National Economic Commission.* Especially pp. 16, 453ff., 516. Part 30, "Technology and Concentration of Economic Power," based on hearings held in April, 1940, provides valuable testimony by both employers and unions on the effects of technological change on employment.

In an effort to supply this deficiency in the study of large changes, the author and his associates undertook field research of a later revolution in steel. A condensation of this study delineates most of the typical problems of massive technological change; it also shows that it is possible for management, union, and community to face intelligently and responsibly the problems posed.

It is clear that, as long as industrial society retains its present dynamic character, technological changes, both major and minor, will continue to occur and to produce tremendous credits—and debits—for industrial society. Since the ghost town era, however, society's approach in the United States to such phenomena has changed markedly. To begin with, the role of the Federal government has been greatly enlarged. Since the Depression government has been committed in principle to stabilizing the economy and to relief measures for cushioning the effect of unemployment, whether of a technological origin or any other.

Besides a shift in government policy, it is of equal note that corporation management has become more sensitive to the social effects of technical change. Many corporations now carefully prepare, sometimes years in advance, to meet the effects of technological revolutions. Transfers between jobs, plants, and divisions cushion the social effects of change. And owing to union insistence, some corporations are now committed to "severance pay" for any employee whose job is terminated because of a new machine. In the past twenty years it has become a deliberate policy of many communities to seek diversification of industries as a protection against the recurrence of massive technological unemployment.

In spite of these evidences of a new approach, the problem of grave hardship due to technological change is still with us. The latest major change phenomenon with a technological origin is, of course, automation. In the section Men, Machines, and Organizations: A Reappraisal, the reader will remember that examples of adjustment problems were given, at both worker and company level. Here we add a case of troubled, but finally successful, adjustment to the installation of office automation. (See F. C. Mann and L. K. Williams under the selection entitled "Office Automation and People.")

We begin the topic of adjustment to small technical changes with a selection by Benjamin Selekman on workers' reactions to shop changes. The author shows change affecting a man's pay, his work relationships, and his job security. The selection combines psychological insight with an awareness that union pressures, politics, and aspirations are deeply involved.

The next selection reports a controlled experiment. In 1948, a now-famous study of technological change was published by L. Coch and J. R. P. French.[2] The case described experimentation by a clothing manufacturer with three different methods of introducing shop changes. The unique feature of this study is its richness in both qualitative and quantitative detail. At the same time, it was one of the few controlled experiments in this problem area. Ten years later, Professor French and others reported a similar successful experiment on a much wider scale in the same company. Included as one of our selections, it is especially significant for three reasons: First, like the original study at Harwood, it is a detailed case study of change by competent observers. Second, it illustrates dramatically the technique of "employee participation" as one appropriate technique for overcoming resistance to technological change in modern industry. Third, the changes introduced included not only new machines, but a complete reengineering of production methods, including new rates of pay. Such changes are often the source of stubborn resistance. Here they were introduced without the loss of either morale or efficiency.

In spite of increasing study given to the economic, social, and human problems of technological change, the question grows in importance and gravity. In the American economy, economic recessions have added to the effects of rapid mechanization by increasing the numbers of the jobless, until, as this book goes to press, the Federal government has recognized "hard-core unemployment" due to mechanization or other causes as a social and economic problem of the first magnitude.

In order to put this problem before the reader as clearly and vividly as possible, we are reprinting a survey article by the experienced labor reporter, A. H. Raskin, entitled "Fears about Automation."

The reader will note parallels in this report to the earlier one reprinted in this section, which is entitled "A Case Study of Technological Unemployment."

It is possible that by the time this book appears, the Federal administration will have mobilized the several interested parties including industry, labor, local communities, and government to make a concerted attack on the problem.

The final selection, "Change and the Future," puts the phenomenon of change due to technical innovations in a much larger perspective. Charles Frankel, the author, who is professor of philosophy at Columbia University, sees the technological changes of the near future as a challenge to many of the basic values of Western civilization.

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[2] L. Coch and J. R. P. French, "Overcoming Resistance to Change," *Human Relations*, vol. I, no. 4, pp. 512–552, 1948. [Reprinted in D. Cartwright and A. Zander (eds.), *Group Dynamics: Research and Theory*, Row, Peterson & Company, Evanston, Ill., 1953.]

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I. IN THE WAKE OF THE WHEEL

From W. L. Bliss, "In the Wake of the Wheel: Introduction of the Wagon to the Papago Indians of Southern Arizona," in Edward Spicer (ed.), *Human Problems in Technological Change: A Casebook,* Russell Sage Foundation, New York, 1952, pp. 23–32.

1. THE PROBLEM

Like other American Indians, the Papagos of southern Arizona knew nothing of the wheel and its uses until the white men came. Relatively isolated in desert country, they did not begin to make much use of wheeled vehicles until shortly before 1900. Their adoption came about partly as the result of a deliberate program of the United States Bureau of Indian Affairs. The program was successful and had far-reaching effects on the simple routine of life in the desert villages.

The Indian agents correctly predicted that the Papagos would find uses for wagons but, so far as is known, no official anticipated the whole train of effects on Papago life. Hence, the introduction of the wagon was not integrated with other plans for the Indians.

What immediate changes in the life of a desert Indian village would you expect from the introduction of a wagon about the year 1900?

2. THE COURSE OF EVENTS

1. Spanish missionaries first came into contact with the Papago Indians in 1687. The missionaries, and the soldiers and few colonists who followed them, brought metal tools, cattle, horses, wheat and other European seeds, as well as Christianity and some ideas of political and military organization. The horses were used for riding and pack animals; but if wheeled vehicles were introduced, the fact is not recorded.

2. For almost 200 years following the first intensive contact with the Jesuit missionaries, the Papagos continued to live at the extreme margin of Spanish influence in the New World. The effects of this contact were

not at all like those farther south, in Mexico. Spaniards were little interested in the desert country and their influence was felt chiefly along the southern and eastern edges of Papago territory. Here Papagos moved into the villages around the mission churches for longer or shorter periods and learned something of new agricultural techniques and products. In the main, life in the desert villages continued very much as it had for hundreds of years.

3. About the middle of the nineteenth century, with the coming of Anglo Americans to southern Arizona after the close of the Mexican War, a new era began for the Papagos. They joined as allies with the Americans against their old enemies, the Apaches, and rendered effective service in pacifying the Apache frontier.

4. The agents of the Bureau of Indian Affairs who first came in contact with the Papagos in the 1860's expressed deep concern for the "poverty-stricken Indians," and efforts were made to help them. Impressed with the Papagos' lack of possessions, the agents undertook as one of their first acts the free distribution of knives, shovels, hoes, and other agricultural implements.

5. Later, a plan was put into effect for giving a farm-wagon to everyone who would agree to build a house in the Mexican adobe style, in place of the brush types traditional among Papagos. Many families in the village where the Indian agent had settled, at the eastern margin of Papago territory, responded during the next few years and received new farm-wagons.

6. The majority of Papagos lived far to the west of the agent's village and were not reached by this first program, so that it was only in the eastern village that wagons came into use.

By the 1890's the program had been changed. A man did not have to build a Mexican-style house; he could obtain a wagon by applying to the agent. Payment could be made at leisure.

7. Three brothers of the headman of the village of Choulik, 60 miles west of the agent's village, had obtained work at various times as laborers on track construction for the Southern Pacific Railroad. They were thus thrown into rather close contact with Anglo Americans and their vehicles in the towns that had grown up along the railroad route.

8. When the brothers heard of the Indian agent's offer, they persuaded the headman to ask for a wagon. About a year after the request, the agent sent word that one was ready. The headman rode to the agency and was supplied with a heavy farm-wagon and harness for a team of horses. He drove the wagon back to his home village.

9. The wagon was put into immediate service and continued in use for several years, until it wore out. It was the beginning of a successful introduction of wagons to all villages in the area neighboring Choulik.

3. RELEVANT FACTORS

The Papago pattern of life rested on a combination of hunting and gathering of wild food (cactus fruits and mesquite beans) with very small-scale flood farming along the intermittent streams. The introduction of cattle by the Spanish added something to Papago subsistence; the Indians allowed the animals to run wherever they could find forage and then hunted them like wild game. Although relatively few horses and mules were brought into the region, the horses multiplied through the years. At first they were sometimes used for food but, by 1900, were commonly employed as pack and riding animals.

Papagos had their own methods of packing. They made saddles of two cylindrical bundles of wheat straw or grass tied together with leather thongs and slung so that one rested on each side of the horse's back. Goods to be transported were put in panniers, made of fiber or rawhide nets, which were slung over the strawpack saddles. A man always rode a loaded animal. Most villages in the vicinity of Choulik had, by 1900, at least a small string of horses, usually one or two for each family.

The Indians customarily changed their residence with the season. During the winter months they lived in the mountains, where there were permanent supplies of water in the form of springs. In the summer they moved down into the valleys to plant and harvest crops of corn, beans, and wheat. The winter and summer villages were from 6 or 8 to 15 or 20 miles apart. Often during the winter in ordinary years, and always in drought years, family groups sought jobs in the Mexican villages of Sonora, among the Pima Indians on the Gila River, or among the newly arrived English-speaking migrants, who were establishing mines and cattle ranches in southern Arizona. The village of Choulik was some 60 miles from the nearest non-Papago settlement and over a hundred from more thickly populated areas like the Gila Valley to the north or the Alter Valley to the south.

Trading expeditions were frequently organized by the Papagos for the purpose of obtaining seeds to plant. Such trips were usually planned by all the males of a village, who would decide on types and quantity of seeds and select several men to go out with pack horses to secure them. Buckskin, grass rope, large baskets, and pottery ollas were the usual trade goods. Papago traders sometimes went as far as 250 miles on such expeditions—reaching Bisbee, Arizona, and Hermosillo, Sonora. Families also traveled annually or every other year to Magdalena, Sonora, on religious pilgrimages to visit the famous image of San Francisco.

Papago villages were small, rarely consisting of more than a hundred people, and were organized as land-using, political units, laying claim to some permanent water supply in the mountains and to an area of arable fields in the valley. Usually a *charco*, a large dirt-banked reservoir, held the domestic water supply for a field village during the summer months.

The 7 to 20 families of a village recognized the leadership of a headman. He, working closely with a council of all the adult men, planned and carried out communal enterprises, such as building water-spreading dams for the fields or repairing the *charco*. Usually all, or nearly all, of the families in a village were related in a patrilineal system. In village meetings, which might be held as frequently as every night, all males attended and addressed each other during proceedings by kinship terms. The village was consequently a closely knit social unit, recognizing communal property in fields, water supply, and wild food resources.

Hardly any surplus was produced in the desert villages, and there was no full-time specialization of labor. All the men, including even the curing and diagnosing shamans, worked in the fields. They took care of the horses and managed their packing, and most men could engage in the simple crafts of leather- and woodworking. Women, besides cooking and performing other household duties, were part-time specialists in pottery-making and basketry. The older boys and girls gathered wood from round about the village, armload by armload, and also carired the water in ollas from the *charcos* or springs to the houses.

4. THE OUTCOME

The wagon was a desirable and nondisruptive innovation from the Papago point of view. Its use resulted, nevertheless, in a long series of small changes and new adjustments which affected everyone in the village. Some of these were of minor importance from any point of view and some were of far-reaching significance.

The men of Choulik quickly trained their horses to pull the wagon. The rawhide tugs which they had been using in plowing were not transferred to the wagon. Instead, manufactured harness, introduced simultaneously with the wagon, was kept in repair, and new harness was bought when the old wore out. The wagon itself was slightly modified by the addition of a simple wooden frame to support blankets as a shade for riders.

Within a few months one of the men of the village learned how to work iron by heating and hammering. He became capable of shoeing horses and keeping the metal parts of the wagon in repair.

The wagon was used intensively from the start, eliminating most of the packing on individual horses. Within a few years the net panniers and pack saddles ceased to be made.

There was also an important effect on another craft. Almost immediately the wagon was turned to use for carrying water from the *charcos* to the households. The only large water containers used up to this time had been the ollas made by the women, and these were easily broken. Following the example of white ranchers, wooden barrels were introduced. They were not very practicable, however, in the dry climate of the Arizona desert, since they dried out rapidly and fell apart. The Papagos turned then to metal barrels, which were unbreakable and unaffected by the dryness. These steadily replaced ollas both for hauling water and for storing it in the houses. The water supply on hand increased, and the number of ollas required by a household decreased. The latter were used only for drinking-water, which remained cooler and sweeter in ollas than in barrels. The making of ollas declined as a craft, with the result that less time of the women was used.

In order to use the wagon for transportation from the summer to the winter village, it became necessary to construct a road. This involved clearing and grading in order to get the wagon over the extremely rough terrain up the mountain to the winter village site. Some engineering skill was developed and a new form of group labor was introduced in which all the men participated.

When the question of moving from the summer to the winter village first arose after the wagon was introduced, the village council met and decided that all seven families of Choulik would use the vehicle in turn. The family that was prepared first, moved first, and was followed by the others as they were ready.

Treating the wagon as a common resource of the village was apparent in other ways. Trading journeys, such as those to procure seeds, were now made by wagon. Since only one or two men, instead of several, were assigned to make the trips, face-to-face contacts with Mexicans on the southern border of the Papago country declined.

Uses to which pack horses had not been put developed for the wagon. In addition to the regular hauling of water, it was also employed for carrying large supplies of firewood. Cutting wood on a large scale by the men of the family, instead of piecemeal gathering by women and children, became a new pattern. Soon this practice led to hauling loads of wood for sale to the nearest towns, as for instance, Tucson. An additional natural resource was thus developed, and Choulik entered the cash economy of the surrounding society in a new way. Villagers began also to be interested in raising a little corn and wheat for sale as the wagon offered an easier means of getting a few sacks to town.

The use of the wagon as a resource of the whole village led to increased cooperation and interaction of the officials of the village government. The management of transportation called for meetings to plan trading expeditions, to assign the wagon for wood and water hauling, and for all the uses to which it was put. In addition, the building and maintenance of roads constituted a new communal activity, which had to be planned and directed by the village council.

5. ANALYSIS

This summary of the first stage in the introduction of the wagon to pack-animal users suggests the complications of a relatively simple technical innovation even in a society well prepared for it. The case is only carried to the point where more than one wagon was acquired by the village. From there on, many other important innovations arrived, and it is less easy to trace the effects of wagon-use alone.

Although the effects of the one introduction require several pages to list, the explanation for each consequent change is fairly simple. The connections between the changes and the primary innovation are clear enough. The point of emphasis is that such connections must be anticipated in any technological introduction, if there is to be an attempt to guide the change. Foreseeing at least some of the interrelations of tools and customs is fundamental.

In the Papago case little or no conscious control of the innovation was exercised by the Indian agent. Interest in the wagon on the part of Choulik people arose from the headman's brothers having seen it used in towns, when they were working for the railroad. Furthermore, it was accident rather than planning that placed the first wagon in the hands of the headman of Choulik. We are not able, with the data at hand, to prove that his position in the village influenced the course of events, but it seems reasonable to infer that the development of communal use was related to that fact. If the wagon had come first into the hands of a person without the status of headman, other results certainly would have been possible, including disrupting shifts in leadership patterns.

The effects on Choulik technology were considerable. Panniers and pack saddles fell into disuse, those specific articles being replaced, as we should expect, by the wagon. The necessity for repairing the wagon led to the creation of a new specialty—blacksmithing. A third readily predictable effect was the introduction of roads and road-building techniques. All of these might have occurred to anyone who did advance thinking.

Other effects were not so obvious. It would have been difficult to say positively in advance that the time spent in pottery-making by women would be reduced, but it might have appeared as a possibility if the nature of the wagon had been reviewed in detail in relation to all the transportation activities of Papagos. Similarly, the changes in wood-gathering might have been anticipated, together with the consequent shift in the division of labor in household economy, involving increased participation of adult males in activities formerly confined to children and, to some extent, women.

Changes in the total economy that took place were probably of the type the Indian agent desired, although there is no record that he foresaw the specific direction they would take. The growth of needs for manufactured harness, metal wagon parts, and for metal barrels linked Papagos with the general American economy in new ways. Of these, the first, as directly connected with the form of the wagon itself, might have easily been predicted; the second, as an indirect result, might have been foreseen only as a possibility.

The development of firewood as a cash resource might have been foreseen as a result of a detailed review of the growing needs of the new towns at the edges of Papago territory, as might also the stimulus which the wagon gave to production of agricultural surpluses.

Acceptance of the wagon as a resource of the whole village under joint management was surely not a part of the expectation of the Indian agent. He probably thought in terms of individual ownership. What happened was an adjustment to the existing social organization and property concepts of the Papagos. The village headman brought the wagon into the culture as a unique resource, like the land, the use of which must be shared. This sharing led to the new group activity of road-building, in accordance with the same pattern as land improvements. Sharing the wagon as a means of trade led to modifications of the trading customs, with consequent effects on the frequency and mode of contact with outsiders. Through the period that we have discussed, the wagon may be regarded as reinforcing the community ties which already existed. Hence, its effects on the social life of the people were as important as those on the technology.

Thus, we see that the introduction of the wagon, simple as the initial event was, had broad repercussions on the Papago way of life. It not only displaced some parts of the technology and established new techniques and specialities; it also resulted in important shifts in the division of labor, had far-reaching effects on the economy, became for a period a strong factor for greater community solidarity, and influenced the relations of Papagos with surrounding peoples.

2. A CASE STUDY OF TECHNOLOGICAL UNEMPLOYMENT

From H. J. Ruttenberg, "The Big Morgue: A Case Study of Technological Unemployment," *Survey Graphic*, April, 1939, pp. 266–269.

As we approached Steelville[1] from the other side of the river, we could see the graceful silvery mill stretching more than half a mile behind the town, at the foot of one of the hills that form the rich industrial Ohio River Valley. The late afternoon sun reflecting from the galvanized roof cast an orange light across the milltown houses and the rusty abandoned mill by the river. Entering at the north end of the vast structure, the endless ceiling drew my eyes until I had the feeling of infinity that one gets staring down a railroad track. We emerged two hours later from the southern end fascinated, exhausted, bewildered.

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[1] All names used are fictitious.

Just before leaving the mill I met Mike Michaels, an officer of the local union, sweeping up paper, bale tie ends, and dust in the shipping room. Mike came to America from Wales in 1904 at the age of fifteen. His father was one of the experienced Welsh hand-mill workers the company imported to run the now abandoned sheet mill when it was first built. Mike had worked there himself for over thirty years until it was closed last year. For twenty years he was a roller, an "aristocrat of labor," earning $12 to $15 a day. Now he was doing a laborer's job, at 63 cents an hour. Less than two hundred of the fifteen hundred displaced sheet mill workers in Steelville found jobs in the strip mill. "What do you think of her?" Mike asked.

"It's impressive," a friend with me replied, "impressive—all that big automatic machinery running virtually without manpower, like the works of a delicate Swiss watch!"

Mike leaned on his broom and with some bitterness said: "Impressive, huh! I'd call it oppressive, I would. Here I am pushing a broom, where I started over thirty years back. I'm not an old man yet. I've not turned fifty. But I'm too old to work on any of that impressive, I call it oppressive, machinery. They got a bunch of button pushers running this mill, young palookas I call them, just kids."

"He merely meant it is impressive mechanically," I interrupted.

Mike pointed to the endless ceiling with the massive machinery under it. "Look at her!" he said. "You know what we call her?—'The Big Morgue.' The few of us old hand-mill men that got something to do here ain't so bad off as the thirteen hundred or more fellows that are out starving on relief or struggling on WPA. When we meet on the street and get to talking we call this 'the Big Morgue,' the place where all our jobs went dead."

No Place for the Displaced

Eighty-five thousand hand-mill workers are less fortunate than Mike Michaels. They are permanently displaced and cannot even get a laboring job in the strip mills. Their plight as individuals is tragic. Ralph Urbanic, typical of the many displaced workers I have talked with, was earning $10 a day in the hand-mill at New Castle, Pa., when it was operating. Of German-Slavic descent, hair just turning gray in his mid-forties, Ralph stands six feet tall, a heavy fellow with strained eyes behind thick glasses. His steel mill experience covers his whole life as a worker, he told me:

> I've worked in this mill for thirty-three years, since I was thirteen years old. Twenty years ago I could have become a welder, but I stuck to the mill 'cause it paid more. They won't call me to work at the strip mill, I'm too old. Maybe my two boys that worked with me in the mill will be called. They're both on WPA, one has two kids, and the other just married last year. If they can save enough money, they'll go into the trucking business. My unemployment compensation ran out last week, and we'll have to go on relief so I can get on WPA. I can't get a job at my trade 'cause the strip mills are putting the hand-mills on the bum. The only work I've had in a year was a few months at Shenango [the other hand-mill in New Castle which normally employs 2800]. Not more than a couple hundred of the twelve hundred men in our mill got work at Shenango, but they've all been let out. Anyway, the Shenango men expect to be through most anytime now. I've spent all my life here, I wouldn't want to leave. Ma and I will have to just get along on lower wages, now that the kids are grown up. My youngest boy and his wife are living with us now. . . . It's terrible. We're all looking for the Government to do something. The fellows on WPA are complainin' that they ain't making enough to live. Isn't there something the Government can do to tax those G—d— machines that put so many men out of work? I can mind when a fellow wouldn't want a nicer town to live in. Twenty-five years ago you would never believe New Castle would come to this. . . .

In New Castle there is still hope, because the idle mill has not been dismantled. Several hand-mill men told me that "there is a rumor in town that the strip mill is a failure, and the company will have to reopen our mill." I heard from more than a score of hand-mill men in Monessen, Pa., where sixteen hundred were displaced, "The company will have to start our mill again when war begins in Europe." All such hopes, however, are gone in Clarksburg and Morgantown, W. Va., and Scottdale, Pa. The companies decided to dismantle their hand-mills there, but finding it was cheaper to give them away, the mills were turned over to the Chamber of Commerce or "a group of citizens" to attract new industries, provided, of course, that steel products were not manufactured in them.

The group reactions of the displaced workers, with one exception, have been as varied as they have been futile. When their mill was closed down, the eleven hundred Elwood, Ind., workers offered to work for 20 percent less wages if the company would resume operations. The offer was rejected for several reasons: one being that even if the men worked for nothing, the company's strip mills could produce a superior product at lower costs. In sharp contrast, the fifteen hundred displaced Portsmouth, Ohio, workers spent their energies in vain trying to promote a company-wide walkout. If their ill-advised efforts had been successful, the only conceivable gain would have been to publicize their tragic plight. The sixteen hundred Monessen workers followed a more logical course. They tried to get the company to employ as many of them as possible in its new Irwin, Pa., strip mill. But the company could not employ more than 20 per cent of them.

The twelve hundred New Castle men, however, banded themselves together into a permanent unemployed-WPA workers organization. At first they concentrated on getting their unemployment compensation checks, and then WPA jobs and relief with a minimum of delay. During the primary elections they carried their town and county for the CIO gubernatorial candidate by a wide margin. Since then they have been pushing a local housing program and laying plans to publicize their plight and the plight of their community. They intend to make the nation, especially Congress, aware that New Castle is fast becoming an industrially stranded community, and that it requires special legislative aid.

Private industry having failed to make any provisions for them, the displaced workers look to the government for assistance. Steel workers who have been deprived of their accustomed way of earning their livelihood in more than a score of towns can be found on relief, WPA, or dependent on a son or daughter, many of whom are in CCC camps or employed by the National Youth Administration. A few find their way back into private industry, usually at much lower-paying jobs. But thousands of the strip mill victims can be found desperate on relief or WPA or hopelessly walking the streets. You can see them in Ohio—Cambridge, Yorkville, Portsmouth, Martins Ferry, Youngstown, Canton; or in the Keystone state—New Castle, Aliquippa, McKeesport, Monessen, Scottdale—and in other states where once prosperous industrial milltowns look upon the country's twenty-seven strip mills as "Grim Reapers." The older workers are outcasts of private industry, while the younger ones are on industry's waiting list, drafted into the army of the unemployed.

New Jobs—For Other Men, Elsewhere

Steel employers hold that special provisions for the displaced workers are unnecessary because the strip mills will create new jobs elsewhere, according to the classic economic principle that the effect of labor saving devices is to stimulate, rather than cut employment. But this is to take the "long view." In every labor saving development, there has been a lag between displacement and the creation of new jobs. And while the principle has so far operated to produce the new jobs in the end, they have seldom, if ever, been jobs for the workers thrown on the labor market by the new machinery. Whatever the final employment results of the strip mills—probably the greatest technological advance of the past decade—the present plight of the eighty-five thousand workers, displaced or about to be displaced, is tragic. Nor is there any present encouragement in the possibilities of new jobs through the development of new industries utilizing the strip mill output. A major strip mill product is tinplate.

A new use developed for tinplate in recent years has been to pack beer in tin cans. But beer cans, in turn, mean displaced glass workers. Sheet steel is another major strip mill product, and a new outlet is being developed for sheet steel in the plumbing fixture industry. But this inevitably means the displacement of workers now employed in foundries producing cast iron, enameled plumbing fixtures. Another outlet for sheet steel, still in a very early stage, is prefabricated steel housing. It is estimated that a prefabricated steel house can be produced and erected with one fourth of the labor required to build a house by conventional methods. But any such development on a large scale would cost the jobs not only of a great body of building trades workers, but also of brick and clay, lumber, cement, and other workers now employed to produce housing materials.

An executive of a large steel company recently challenged me to prove that eighty-five thousand jobs are being eliminated by the strip mills. After a lengthy and heated conversation he admitted that "at least eighty-five thousand men are through." "But," he added, "why raise such a fuss about them? They are not a big factor when you consider them with the several million unemployed. Anyway it's almost history and nothing can be done for them now."

"I am raising 'a fuss' as you call it," I replied, "because the numbers of displaced steel workers are being increased by new mechanical advances so fast that special provisions will have to be made for them."

Most of these labor saving advances have been small mechanical improvements eliminating two men here, a dozen there. In Johnstown, Pa., a handful of "scarfers" replaced several dozen chippers. The scarfers, with their acetylene torches, can burn the bad seams out of billets five times as fast as chippers can cut them out with their air pressure chisels. A steel roll mill recently installed two new small electric furnaces which can be charged automatically in twenty minutes. It took two and one half hours to charge the old furnaces by hand. Four men were eliminated from the furnace crews.

Not long ago I went through the continuous pipe mill in Etna, Pa. A crew of twelve men operate it, producing nine hundred pieces of pipe in eight hours. The mill superintendent told me that twenty-six men on the hand butt-weld pipe mill could produce only eight hundred pieces in the same time, an increase in output per man of 240 percent. Half inch pipe was going through the new continuous pipe mill at the rate of two hundred and eighty feet a minute. In five days that mill, operating with its relatively small force, can produce enough half-inch pipe to reach from Pittsburgh to New York.

The Rush toward Smaller Payrolls

All this is "small stuff" which has been going on in the industry for years, though when all these lost jobs are added up the total is startling.

But far more ominous, from the standpoint of employment, are pending technological advances in steel manufacturing.

The present method requires eight operations from the open hearth furnace to the rolling mill, and the steel has to be transported four times. When the process of rolling molten steel has been perfected—and enough progress has been made to indicate that the process will be commercially feasible within the next decade—only three operations will be necessary, and the steel need be transported but once. Entire departments, including the soaking pits, blooming mills, chipping yards, and so on, will be abolished or reduced to mere skeletons. Roughly, one out of every six steel workers will be eliminated by the process. Many steel men say steel will never be rolled in molten form, but to most experts the idea seems less fantastic than did the idea of the strip mill twenty years ago.

The head of the steel company that is doing the pioneer work in developing the process of rolling steel in molten form told me:

> We have done it. I've seen it done. We have rolled strip steel from its molten form in two hundred foot coils, fifteen inches wide. I have had this steel examined in more than a dozen laboratories. It is far superior to our present steel, because it does not have the imperfections caused by "ingotism," the chilling and reheating of steel. I can't watch our experimental laboratory roll molten steel for more than a few minutes. It almost makes a fellow go crazy thinking about the millions of dollars worth of equipment it will make obsolete, and the thousands of jobs it will eliminate. It's terrific.

The president of another firm told me of an experimental process that will prolong the life of steel. By applying a thin coating of nickel, these experiments indicate, steel will be made more corrosion-proof than highly expensive alloy steel, and the active life of certain steel products thus multiplied from one to three times. No accurate estimate can now be made of the effect this more enduring product would have on employment, but certainly the tendency would be to reduce further the inadequate number of weeks of work steel workers now get annually.

Neither the industry nor the Steel Workers Organizing Committee is making a plea for "the good old days"; but neither has a solution at hand for the problem of the displaced workers.

What Can Be Done about It?

The strip mills are a pre-union development, more than 85 per cent of them in operation before the SWOC was established. The steel workers therefore cannot expect to receive benefits from the union for a period when they were unorganized. The men lacked union leadership to control and plan the introduction of the strip mills, and many of them were scarcely aware of the new development. With few exceptions, the strip mills were not built as neighbors of the hand-mills. The Irwin strip mill of U.S. Steel, for example, is on a hill overlooking the Monongahela River. Hand-mill workers ten miles up the Monongahela and sixty miles down the Ohio River were not aware of the significance for them until they saw their mills closed down for good. If management were to install in a mill with one hundred employes a labor saving device that would eliminate eighty-five workers, even leaderless men would instinctively protest and resist.

The SWOC favors technological improvements and carries on a continual program of education among its members as to the futility of opposing progress. But unless provisions are made to care for displaced workers, the speed with which industry is introducing labor saving devices may be checked by the revolt of the men involved. SWOC has proposed a practical plan to govern the introduction of labor saving devices in a pamphlet, *Production Problems*, which has been widely circulated throughout industry. The program provides for union cooperation with management to "reduce costs, enlarge sales, improve quality," while management agrees "to share equitably with the union any benefits so obtained." The program further provides that "nobody is to lose his job as a result of any improvement that is installed. If ways are discovered to do more work with less labor, they are to be put in gradually . . . in such a way that no discharges are necessary—as for instance at a time when sales and output are increasing."

But all this is intended to apply mainly to the introduction of new devices that displace small numbers of men. Wholesale displacements by such production improvements as the strip mills or rolling molten steel present a much more difficult problem. The numbers involved are so great that they cannot be absorbed gradually in the normal working force of a single company.

Such developments indicate to the union the inevitability of the thirty-hour week at existing or, more likely, higher wages. Organized labor expects the steel industry to resist the thirty-hour week, as it did the eight-hour day in 1919 and the forty-hour week in 1936. The steel workers urge a thorough-going study of technological change and its effect on employment, as the basis for an adequate program. At its recent convention, the Congress of Industrial Organizations, with which the SWOC is affiliated, unanimously favored:

> . . . an immediate and thorough-going survey of technological unemployment and its consequences; a further shortening of the number of hours of work per day and the total number of hours per week, without any decrease in establishing wages under collective bargaining agreements or minimum wage and hour legislation until the goal of a six-hour day and thirty-hour week is reached; and measures which will assure to the work-

> ers full employment and just distribution of the benefits of technological improvements.

Such an investigation under impartial public auspices and a plan based on it are long overdue. The survey should include special studies of such stranded communities as New Castle, Pa., in the hope of helping them before they become incurably blighted areas. In October 1938, 20 per cent of New Castle's population was on relief and WPA, 3 per cent more than the state average. In addition, 16 per cent of the population is directly dependent upon the hand-mill that will shortly suffer the fate of the abandoned mills. Before long one third or more of New Castle's wage earners will be on relief or WPA. More than a score of steel towns face an equally dark future, and there is no plan now in process for meeting their need.

The swift, steady displacement of workers by machines in the steel industry is no doubt an example—if an extreme one—of what is happening in many areas throughout industry. Here is one of the grave problems of the machine age, one that cannot be solved except through the common effort of industry, labor and government.

3. TIME AND TECHNOLOGY: A CASE STUDY OF SOCIAL ADJUSTMENT TO CHANGE

Adapted from C. R. Walker, *Steeltown*, Harper & Brothers, New York, 1950.

The introduction of the continuous strip mill in the steel industry during the 1930's was carried out by the industry with little regard to the various "publics" which might be affected by the change. These "publics" included the workers, the union, the community, and even local management in the plants which were shut down.

During the 1940's, further major technological innovations were made in the steel industry, but by this time top management's actions were no longer unilateral. Other parties at interest, especially the steelworkers' union, had considerable influence on management's actions. We propose to illustrate here, by means of a case example, how a managerial decision and the consequences of it were substantially influenced by the reactions of a union and community.

The Ellwood City story began much the same as New Castle and the several other communities which felt the impact of the continuous strip mill. During World War II, the U. S. Steel Corporation decided that the company's traditional methods of rolling tube were obsolete. In order to reduce costs and to compete in the post-war market, it was necessary to switch to manufacturing seamless pipe on the continuous-flow principle.

A central question was whether to renovate or rebuild facilities in the location of the older plants or whether to build completely new facilities elsewhere. Ellwood City was one of the communities which had been making pipe since 1895 by the traditional non-continuous method. For many reasons it was decided that it was not feasible to continue the Ellwood City operations; among the reasons given was the fact that transportation costs would be lower if new facilities were established farther west. (This was true both for the intake of raw materials and for distribution of the finished product.) Considerable savings in handling and transportation costs could also be realized by fabricating the pipe in the same location as basic steel production. The corporation owned such basic steel facilities in Lorain, Ohio (where it also made pipe by the old process) and at Gary, Indiana.

When it returned to normal operations after World War II, the Ellwood City plant of the National Tube Company (a subsidiary of the U. S. Steel Corporation) employed approximately four thousand persons, or two thirds of the wage-earners in a town with a total population of 11,000. Not only was the mill located in the center of the town geographically, but it was central to the community's entire economy.

For many years the people of Ellwood City had heard rumors that its plant was "obsolete" and that it might move. Little stock was taken in the rumors inasmuch as the workers and local management firmly believed that their skills were essential to the making of specialty tube products. And, as they proudly observed, the seamless tube industry had begun in Ellwood City in 1895.

The first indication that the corporation was in the process of deciding to abandon the Ellwood mill came from the Governor of Pennsylvania in a speech on August 22, 1945, commemorating the fiftieth anniversary of the making of seamless steel tubing in Ellwood City. In the middle of his speech he threw a bombshell. *The mill might move west.*

As a union representative later remarked, "It was a blow right between the eyes. The whole community was stunned—not just the union and the workers, but the merchants, the townspeople, the Chamber of Commerce. We all felt the same way. . . ."

The Governor's remarks set in motion a whole series of events during the following years. The details of these events are recorded in *Steeltown.* Here we shall only touch on the highlights, singling out certain interesting and important episodes which illustrate, in contrast to the strip-mill revolution of the 1930's, how active the parties at interest became when faced with a crisis which threatened an entire town.

The first action in response to the Governor's remarks was taken by the president of the union local. In a strong letter to the Governor, he demanded clarification of "certain allegations you made concerning the future well-being of our city."

The Governor quickly replied that he was "in possession of confidential information" about the matter (indicating that he had reasonable grounds for anticipating the move), but that he would do everything in his power to "keep our industries here."

Shortly thereafter, the president of the National Tube Company informed the international officers of the union that a move was being considered. In November, 1945, the superintendent of the Ellwood Works notified the local that a move was being contemplated, but that no decision had been reached.

In December a mass meeting was held in town and attended by leading citizens, merchants, the Chamber of Commerce, and union leaders. The purpose of the meeting was to consider ways of preventing the decision from being made. The union's international representative came up with the unusual suggestion that the mill might be saved through a reduction of "featherbedding" and by economies including some reduction in the work force.

In January, 1946, the union met with the local mill authorities to discuss how economies could be made in mill operations. Local management, equally concerned about the move, welcomed the suggestions, and during the next four months several cost reductions were made. It was assumed that reports of the results of the joint activities would be transmitted to the company, which they were, and that the company would respond.

Several months went by and neither local management nor the union heard any word from the company. Then on August 1, 1946, came the public announcement by the head of the company that the Ellwood plant was going to move. The announcement spelled out the reasons, most of which revolved around the need to economize in order to compete in the market.

What was significant about the announcement was that the move was to take place not immediately but in three years. Unlike the actions of the corporation ten years earlier in the case of the announcement of immediate abandonment of the old strip mills, management recognized the necessity of giving its employees and the community time to plan and to adjust. A top management official told this author that the "only fair course to take" was to "confide in the employees and the community at large by telling the whole story well in advance of the termination date." Another important feature of the announcement was that management offered employment to all displaced persons at other company locations.

On August 12, 1946, representatives of the Chamber of Commerce met with officials of the National Tube Company in order to discuss ways in which other industries could be attracted to Ellwood City to take up the slack. By the end of the month, a non-profit "Industrial Corporation" had been formed by leading citizens of the business community for the purpose of building or renovating facilities to bring in small diversified industry. The Tube Company offered to help the Industrial Corporation to find a buyer for the mill facilities. It also offered to give preference to structural steel for building new plants.

The union concentrated on the problem of relocating the workers. In October, 1946, a conference was held between company officials and union representatives—those from Ellwood City and from Lorain and Gary where the new mills were to be constructed—and other top union officials. The question of the transfer of seniority was central to these discussions. No agreement was reached. The representatives from Lorain and Gary did not want their own members to be replaced by "outsiders."

In order to dispel rumors that the mill might not move and to demonstrate that the company wanted to do what it could to make the adjustment more tolerable, a letter was sent to all employees by the company president. The letter stated that the company would recognize continuous service for pension and vacation purposes for all those who would make the transfer. The letter further stated that the company was trying to work out a seniority agreement with the union. Finally, it stated that the company would do what it could to encourage other industries to move to Ellwood City.

A month later, on December 16th, the union requested and was granted a meeting with top company officials. The purpose of the meeting was to try to persuade the company to reverse its decision in light of the collaborative efforts of local management and the union to lower operating costs. Attending the meeting were the president and vice-president of the company, the plant superintendent, and the district and local union officials. The company made it clear that the decision was "beyond recall," and attention was focussed on the problems of seniority, pensions, and the possible sale of the Ellwood property to another manufacturer. The union was invited and it accepted an invitation to visit Gary to inspect the community and the plant where the new facilities would be located.

In the following four months in the early part of 1947, the community (but not the union) focussed its attention on the activities of the local Industrial Corporation. The campaign for funds to encourage new industries to come to Ellwood City had resulted in the sale of $150,000 worth of stock. In April, 1947, the Industrial Corporation announced that ten new manufacturing companies were planning to locate in Ellwood. Although the potential employment by these companies was only a fraction of the tube mill employment, many people regarded the efforts of the

Industrial Corporation as a step forward in preparation for meeting the devastating impact of the tube mill shutdown.

We come now to an episode of major importance. To Ellwood City's surprise—and to the union's, too—a move was made which suddenly thrust the personal problems of the tube mill workers and the community into the bright glare of national publicity.

Dissatisfied with the "beyond recall" declaration of the company with respect to the move, the union local sought some means to take the Ellwood City question beyond the National Tube Company and to the attention of top management of U. S. Steel. Armed with eleven stockholders' proxies in his pocket, the local international representative addressed Big Steel's annual stockholders' meeting. This was the first time in the history of the United States Steel Corporation that a union, acting as representative of shareholders, had appeared at an annual meeting.

The *New York Herald Tribune* on May 6th reported the episode as follows:

> *Union Resists Move.* Sam G. Neff, a steelworkers' union representative from Ellwood City, Pa., was heard in a strong plea to management to relent the decision to move pipe-making operations from Ellwood to Lorain, Ohio, 160 miles distant, and to Gary, Ind., 500 miles away. The 4000 steelworkers and total population of 15,000 of Ellwood City, he said, were waiting "like condemned" for the city to die. "Tragedy stalks the streets and suspense is like waiting under the threat of an atomic bomb," Mr. Neff said, adding that workers concerned were willing to "cut wages, reduce incentive rates, and eliminate featherbedding" if Steel's National Tube plant at Ellwood City would only continue.
>
> Mr. Olds [Chairman of the Board of U. S. Steel] pointed out that notice of the Ellwood City move had been given to workers and residents about three years ago and was impelled by steel economics caused by the shift of demand westward. Employment had been offered to Ellwood City workers at other United States Steel plants. Benjamin Fairless, president of United States Steel, arranged for a conference following the meeting with Mr. Neff and two other union representatives.

An analysis of Mr. Neff's speech shows a highly charged mixture of emotional humanitarianism and cold economic appeal to his hearers. The first half of the speech touched on almost every possible emotion that could be tied to the move: gratitude for the loyalty and past service of the steelworkers, who for fifty years had worked for the company; patriotism—as proved by the workers' excellent war record; feeling for the community with its homes, churches, etc., now about to be destroyed. Following this came the request, "I am appealing to you . . . to reconsider. . . ." The speaker then turned to economic arguments, after this mildly barbed transition: "I appeal to everything that is human in you people . . . but if that is insufficient, I would like to appeal to you in an economic sense. . . . We feel . . . that the decision to move these facilities to Gary, or at least to abandon those in Ellwood and build anew in Gary is economically unsound insofar as the seamless specialty business is concerned. We feel we can prove what we say. . . . I am asking you [the Chairman] and the directors to at least give the people of Ellwood City a hearing." This was clearly the heart and object of the speech—an appeal for a hearing. The appeal was granted and a first hearing held four days later.

For the union, one of the prime objectives of the appearance at the stockholders' meeting had been achieved: a hearing had been promised. The delegation returned to Ellwood City and began to prepare "briefs" for the meeting with the corporation president.

The meeting between the representatives of Local 1220 and the president of the U. S. Steel Corporation took place in the latter's office in Pittsburgh on May 10, 1947. With the international representative acting as spokesman, the union presented its case for a "reconsideration" of the move from Ellwood City to Gary.

At the close of the meeting, two events of importance to this inquiry occurred. The corporation president promised to make a resurvey of the Ellwood question and to visit personally Ellwood City and the tube works. The other event was the fortuitous birth of the "Save Ellwood Committee." The delegation which met with the president of the steel corporation had not considered itself a committee until a reporter asked one of the union representatives what the group called itself. He replied that it was simply a group of "union people." "We are here to try to save Ellwood City." The reporter was quick to say, "Why not call it the 'Save Ellwood Committee'?" The group nodded its approval, and the "Save Ellwood Committee" was born.

For a few days after the stockholders' meeting and the union-management meeting in Pittsburgh, the plight of Ellwood City was national news. The *New York Times*, the *New York Herald Tribune*, and the Pittsburgh papers printed substantial accounts of the stockholders' meeting. The AP carried the story, and a week later *Life* gave it to the world in pictures. For three days the *Ellwood City Ledger* hesitated and then printed the story in full with a photograph of the international representative addressing the stockholders. Finally, on May 8th the *Ledger* gave a front-page story and a banner headline to the union's Pittsburgh conference with the president of the steel corporation.

Almost a year went by and the president of the corporation had not yet fulfilled his promise to visit Ellwood City. Impatient with the delay, the union undertook other measures "to save Ellwood City from becoming a ghost town." In June, 1947, a union delegation requested and obtained an interview with the president of a smaller steel company to try to persuade him to buy the Ellwood facilities. The suggestion was seriously considered but ultimately rejected.

In July, 1947, the international representative visited Kenneth C. Royall, about to be appointed Secretary of the Army. The tactic was used in order to emphasize that if the international situation worsened, it would be a serious mistake to abandon the Ellwood works. The meeting received some local publicity, but no action was taken by the government.

Between August, 1947, and February, 1948, the union went into action along another tack. It threw itself vigorously behind the Ohio-Beaver-Mahoning Canal project. The proposed canal would connect the area in which Ellwood City was located with the Great Lakes by a navigable water route. Focussing on the immediate Ellwood problem, the union argued that if the canal went through, it would destroy one of the company's arguments for moving—high cost of transportation. The union worked closely with the Youngstown Chamber of Commerce in promoting the program. It also launched a drive for 15,000 signatures of union men in the area to bring about political pressure for action on the canal. Again there were no results; the canal project was not implemented by Congress.

In retrospect, the union's actions demonstrate a remarkable departure from what is generally considered a union's function within its own "frame of reference." In trying to block the move, or at least to ameliorate its effects, the union was establishing new relationships which had not existed before. It resorted not to traditional union tactics such as the strike, but to tactics more characteristic of the business community. It gained access to the stockholders' meeting as holders of stock proxies. It approached the president of another steel company to point out the economic advantages of purchasing the Ellwood plant. It went to the Army, not to make a humanitarian appeal, but to argue on the basis of critical productive facilities in the face of possible international conflict. It worked with the head of the Chamber of Commerce in another city on the canal project; this necessitated discussions with the Army Corps of Engineers, industrialists, political leaders, and many other groups in addition to union groups. In short, the union was in the business of "business," acting in much the same way a company might act to keep from being destroyed by competition.

By the beginning of 1948, its major project—getting the corporation to change its mind on the move—had resulted in no response by the corporation. The union and the community still waited for the president's promised visit.

In February the union adopted still another tactic to stimulate action. Again the tactic was not based on a humanitarian appeal, but was economic in character. It was designed to show the company and the parent corporation that since the original decision, the Ellwood plant had improved its productivity and had lowered costs. Confidential production records for the year were secured by the union and sent to the presidents of the company and the corporation. Although never proven, there was some indication that local management had not hindered the union in acquiring this information. However, the union's action was sharply condemned by top management on the basis that the production records were none of the union's business and that their possession of such information might permit it to fall into the hands of competitors.

Three months later in May of 1948 (fully a year after his promise to do so), Benjamin Fairless, president of the corporation, made his long-awaited visit to Ellwood City. The character of the visit and its significance merit some detail. As reported in *Steeltown:*

> He arrived by car in Ellwood City shortly before 12:30 P.M. on May 2, 1948, accompanied by the president of the National Tube Company. To a group of plant, union, and town representatives assembled for luncheon, the president of the corporation said, "I know what you are all thinking. I know you would like me to say a few words and sit down. I know what you would like those words to be. No one in this room would like more than I to say them and sit down—but I can't."
>
> The unsaid—and unsayable words—of course, to which the president referred were, "The mill will not move." The president's remarks reveal how accurately—and humanly—he had diagnosed the temper of his Ellwood audience. It also reveals the basic difficulty of his self-imposed assignment. . . .

As reported by the *Ellwood City Ledger:*

> He said that the corporation was considering three possible angles of the problem: whether or not the plant should continue to operate intact; second, whether there would be a partial operation here; and third, whether or not it would be abandoned and transferred.
>
> He pointed to the troublesome times and said no man could predict the future and that he did not know all the answers. He did assure the people of Ellwood City that U. S. Steel felt it had an obligation both to the workers and the community. . . .
>
> The climax of the occasion came when, by inference, he embraced all groups in the "Save Ellwood Committee"—and asked that he and the president of the tube company be allowed to join too. The luncheon guests applauded with enthusiasm.
>
> Immediately after lunch, a tour of the plant began. Here the union, sensing its opportunity, "captured" the president of the steel corporation for the duration of the tour. As he moved from department to department, the grievance man for each stepped forward and walked beside the chief executive. There were scores of handshakings with department

> superintendents, foremen, and workers and, significantly, half of the supervisors who met the president were introduced by the union representatives. Local management made no effort to interfere with Local 1220's possessive hospitality.
>
> The mill gave the appearance of having been scrubbed and ironed for a military inspection. Hot Mill No. 5 was running its biggest size tubing and No. 3 Mill was making a very fast run. The Cold Draw Department made the greatest run in its history. There were no mill change-overs during the tour, and the pipe appeared to be coming through the mills with split-second timing.
>
> At moments the visitors appeared intent on these demonstrations of mechanical and human efficiency; at others, they were grinning, shaking hands, and swapping stories. To an outsider, the affair appeared to participate in the several qualities of a military inspection, a demonstration of athletic skill and strength, and a reunion of old friends.

During the months following the visit, although the president's words were generally interpreted as meaning a "reprieve" for Ellwood City, it was thought by all parties that the move had merely been postponed. In fact, however, it never did take place. In 1959, fourteen years after the Governor of Pennsylvania dropped the famous bombshell—"The mill might move west"—the Ellwood plant was operating at full capacity. Furthermore, because of the skill of the workers in the production of specialty products, the company had transferred all of its stainless steel production to the Ellwood works. New and improved machining and facilities were being installed. Ellwood's future was assured.

In recalling the history of the plant, a company official had this to say:

> The original decision to move was based on a potential market analysis. It appeared that the westward shift in the market, the necessity to integrate tube-making with basic steel production, plus the expected productivity from the new continuous mills would make the Ellwood plant obsolete. As it turned out, the economy in general and tube-manufacturing in particular expanded far beyond the original estimates.
>
> But what made the company take a second, third, and fourth look at Ellwood was Ellwood's own ability to show a profit. We underestimated what it could do, and the president who originally made the decision did not fully comprehend either the public reaction or the importance of the local skills. Both local management and the workers pitched in and showed they could really make Ellwood produce at a profit in spite of their obsolescence, and looking back we cannot deny that the dramatic efforts to call these facts to our attention had a substantial effect. Had it not been brought to our attention, the mill might have moved.
>
> Put it this way: The delay in making the final decision to move allowed new and unpredicted market conditions to begin to work. Then came the Korean War. After that it was becoming obvious that Ellwood with its skills was the place to make stainless steel tubing—the most difficult of

> any type of tube. In 1958 the president of the company personally visited Ellwood City and announced the decision to move all stainless production to the Ellwood works. He further announced an equipment modernization program. It is also important to point out that the early efforts to locate new industry in Ellwood City paid off. Today more than a thousand people are employed in a number of small plants, none of which is related to the tube-making business.
>
> Ellwood City has a new lease on life, and it looks as if the lease is permanent.

In its historical perspective, the Ellwood City story may be said to represent an in-between stage: a stage between completely unilateral action by an industry—such as had been the case when the strip mills were abandoned in the 1930's—and full cooperation among all parties at interest—as is sometimes found today in planning for and making adjustments to major technological changes.

In this middle or in-between stage, we note the emergence of a new pattern of relationships among the different groups concerned with the problems of change. Management not only acted on the basis of economic and technical imperatives, but it *reacted* to the pressures of the union and of the community. The union went far beyond its traditional role as the bargaining agent on limited matters of wages, hours, and working conditions; it established a broader relationship to the company, and it became a "negotiator" with many other agents in the economic and political community. The town itself through its local business representatives not only established a new kind of relationship with the company, but it sought to bring in diversified industry—an action which was later to become common all over the country in formerly one-industry towns.

Thus we see in this case a general broadening of a sense of responsibility and of interdependence among groups which had formerly acted separately. It is true that the several actions were often crudely conceived; actions and reactions occurred as a result of immediate threats to individual limited spheres of interest. There was no sustained long-range joint planning. (It is this lack of joint planning which categorizes this case as being in an interim stage between unilateral action and mature cooperation.) Finally, what began as a possible tragedy of major proportions ended as a triumph of considerable practical as well as theoretical significance. The tragedy was avoided because, willingly or not, the people involved began to communicate with one another. This in turn gave them time to re-evaluate the situation.

For the policy makers and other leaders involved in this case history—executives of the steel industry, officers of the steelworkers' union, leaders of the community—time was obviously of the essence. The decision itself was based upon a knowledge of past market trends and upon a calculated prediction of future ones. The union's participation in the joint economy program was a time calculation. Finally, the community acted as quickly as possible to bring in new industry before the move should take place. In fact, all parties attempted to time their actions with reference to the economic, political, and social forces bearing upon their individual interests. One of these parties (management) may be criticized for allowing too much time to elapse between communications on matters of vital interest to the workers. On the other hand, the *timeliness* should be noted of management's advance announcement of its decision. In all such matters it is probably impossible to exaggerate the importance of enough time for adjustment, for planning, for preparation, and for understanding.

4. OFFICE AUTOMATION AND PEOPLE

From F. C. Mann and L. K. Williams, "Observations on the Dynamics of a Change to Electronic Data Processing Equipment," *Administrative Science Quarterly*, vol. 5, pp. 217–256, September, 1960.

The introduction of automation in the factory and electronic data processing (EDP) in the office has presented social scientists with unique laboratories for investigating the dynamics of organization and processes of change. This paper will summarize some of our findings concerning one such study—a study of the effects of a change-over to EDP equipment. This paper is titled "observations concerning a change-over" to emphasize that our findings have no firm quantitative foundation; they are based on materials from over three hundred unstructured interviews taken as various phases of the change have unfolded.

The company in which this change-over occurred produces and sells electric light and power. It is one of the largest in the United States, serving well over a million customers. Two major divisions are primarily concerned with the accounts of these million customers: Accounting, which is responsible for all customer billing, bookkeeping, and records, and Sales, which handles all direct contacts with customers relating to service and the payments of their accounts. The installation of EDP to maintain customers' accounts had immediate and direct effect on the Accounting Division, its organization and personnel. Our study, therefore, concentrated on the change as experienced in [this] Division.

The change was initiated with very little fan-fare in October 1953, when top management announced that a study would be made of the customer accounting and collection function. One year later, after a number of analyses had been completed and evaluated, it was decided to implement recommendations for reorganization of work within and between the Accounting and Sales Divisions. Among these recommendations was a plan for the consolidation and centralization of all record-keeping and calculating work into one data processing group. This was to be [facilitated by] the installation of electronic accounting equipment. On the data processing side, one master record containing all customer information was to be placed on magnetic tape for use with an IBM 705. In terms of organizational structure, conversion to electronic equipment called for considerable realignment, involving extensive transfers of functions and employees from one major division to another, and *a major reorganization* within the Accounting Division. Indeed, studies of the feasibility of introducing EDP equipment placed key members of management in the relatively rare position of being able not only to rethink the organization of work within specific divisional areas, but to redesign the organization, taking advantage of the climate of change to cut across old divisional lines. Many of the economies which accompanied the introduction of EDP probably could have been made without the equipment *if* the same original and broad gauge thinking had been applied to existing operations and equipment.

The period of transition stretched out over five years and during this long period continuity of operations had to be maintained. Activity in all departments mounted as the date for the installation and initial testing of the 705 equipment and programs approached. The machine was delivered in October 1956—almost three years after the feasibility study was announced.

Pressure mounted during late 1956 until fatigue and stress reached a climax for a number of key personnel. A heart attack dramatized for all both the tempo and the level of tension. The change of records from the old to the new equipment finally got underway in mid-March 1957 and continued during the remainder of the year as personnel, equipment, and procedures were tested, found unsuccessful, or found wanting and replaced. By early 1958 the system was technically sound, and more fully understood and accepted. Attention was then turned to the massive task of reassignment and the establishment of permanent jobs and relationships.

This brief résumé gives some feeling of the change which occurred in the nature and tempo of work in the departments within the Accounting Division. It went from a period in which system maintenance was the principal task through a period when attention was focussed on system creation and revision while still performing all the functions of the old system to a period in which a new equilibrium was being established under the new system.

In the remainder of this paper, we shall discuss, first, some of the major changes in philosophy, policy, and practice that accompanied the conversion. Next, we will be concerned with some of the more specific problems of transition. Finally, we will describe the problems of reassignment and restructuring, and provide a final overview of the organization with its new jobs, new structure, and new relationships.

A change-over on this scale provided a crucial test of the corporation's philosophy of participative management. Over the years much effort had been invested in developing the abilities of the intermediate and first-line supervisors to understand and practice the principles of participative management. The rewards from this investment became apparent again and again as Accounting department heads and their supervisors worked together on the technical problems of the conversion which required a common management approach toward change. Intra-organizational conflict was kept to a minimum because of the similarity of such values as notifying people in advance of each step of the change, involving subordinates in the development of the plans for their part in the change, and employing other democratic human relations principles.

The introduction of electronic equipment caused the development and elaboration of company policy in a number of different areas. Probably the most important was the area of policy regarding the employment security of the personnel affected by the change. It was estimated that the consolidation and simplification of records, the mechanization of additional clerical records, and the use of electronic data processing equipment would result in a marked reduction in both the clerical and the supervisory work forces. The specter of this eventual reduction in labor force could have created a serious morale problem, augmented resistances to reorganization of the system, and even severely retarded the introduction of the new equipment.

Since such potential technological unemployment could affect not only the non-supervisory and supervisory employees directly involved, but members of higher levels of management as well, policies regarding the rights of displaced employees began to be spelled out during this period. The general policy which first evolved was as follows:

> Whenever practicable, regular employees whose jobs have been discontinued will be transferred to equivalent assignments for which they are qualified, and at the same rates of pay. It is recognized, however, that permanent assignments to the same rated jobs may not be immediately possible for all employees. When permanent transfers cannot be made, departments are expected to endeavor to provide the most suitable temporary work possible, anywhere in the company. It is the continuing responsibility of the department head to see that such employees are eventually placed in permanent positions—after training if necessary.

It is worth emphasizing that in the development of this type of policy the company went a step further than previously in formalizing its obligation to its permanent and long service employees. It offered employment security, but not the assurance of a particular job to an employee. Such a policy accomplishes several objectives simultaneously. It demonstrates the organization's concern for the welfare of its personnel, helps ensure the assistance of those on whom the company must rely to accomplish the change-over, and reduces the likelihood of unionization of white collar workers as they experience a major threat to their livelihood.

Of the demands placed on management during this transitional period one of the most important was the need to maintain simultaneously three systems of accounting: the old, the conversion, and the new. Manning, operating, and coordinating all three systems was a rigorous test of the abilities and skills of all levels of management in Accounting.

When change is gradual, managers and supervisors, like employees, become thoroughly familiar with that part of the total work process for which they are immediately responsible. With such a drastic change it was necessary for them to develop a much broader view of the system. But the effective supervisor during such a period must not only change his perspective of his role. He must, along with his superiors, be able to draw upon different combinations of skills at different times. Conceptually, we have found it useful to think of three areas of supervisory skills or competences: technical, administrative, and human relations skills.[1] When an organization is in a relatively stable state, the supervisor has to draw heavily upon abilities that ensure organizational maintenance and effective human relations. By contrast, a transition period places a heavy stress on the supervisor's technical competence and cognitive skills. The problems of the transition period were basically technical, and only technical knowledge could solve them. Human relations skills were not unimportant, but the job of laying out operationally feasible plans for complex changes in the accounting systems demanded technical competence. Supervisors without adequate resources in terms of these three skill components found the going extremely difficult at different periods during the transition.[2]

Training was one of the largest problems continually facing supervisors. Throughout the change period, supervisors complained simultaneously about the lack of time to do adequate training and about the great amount of time being consumed in training. Not only were there many replacements on old jobs who had to be trained but also old employees assigned to new tasks who had to be retrained. Frequently training had to be done on overtime. Training for new jobs was particularly difficult. For example, the first people on new jobs in programming, often had to be trained on a process with materials with which neither the supervisor who was doing the training nor the trainee had had any experience.

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[1] F. C. Mann and L. R. Hoffman, *Automation and the Worker: A Study of Social Change in Power Plants*, Holt, Rinehart and Winston, Inc., New York, 1960.

[2] F. C. Mann and L. K. Williams, "Organizational Impact on White Collar Automation," *Proceedings of the Eleventh Annual Meeting, Industrial Relations Research Association,* 1958.

First-line supervisors were faced with quite different morale problems during this period of instability. Some had to try to keep their groups working on activities which all knew would be replaced shortly. Others were trying to develop the required new job skills in older employees who would have preferred to have gone on until retirement doing those things they had grown to know so well over the years. Still other supervisors were finding it difficult to keep ahead of their subordinates who were rushing ahead to learn new procedures, nomenclature, and the intricacies of the electronic data processing world without any inhibiting knowledge about the old system. A few supervisors were encountering the problems attendant upon introducing white collar personnel to shift work. Nearly all were able to see the effects of continued overtime and its high cost in terms of fatigue and decreasing productivity.

Another major problem faced by management was the meeting of schedules and principal target dates which had been set early in the planning phase on the basis of little knowledge. In need of some reference points the tentative dates and schedules soon became fixed goals. Perhaps the most serious psychological stress occurred just before the actual conversion date was missed. It had served well as a goal but as the target date neared it became increasingly obvious to key department heads that the date would not be realized, yet all were reluctant to make the pronouncement which would indicate failure. As a group they finally were able to acknowledge that the rapidly approaching deadline would not be met. This admission of the failure, without any pinpointing of blame, came as a relief to many. Subsequently, conversion dates and other targets became less public, and smaller, more meaningful segments of change were set as sub-goals.

Despite these kinds of problems, management was able to continue a high and sustained level of activity without any crippling dissatisfaction or morale problems throughout the transition period. The high degree of involvement, the feeling of personal development, and the sense of team accomplishment undoubtedly did much to maintain satisfaction in what can best be described as a stressful and at times even a chaotic period.

Non-supervisory personnel experienced different types of stress at different times during the change period. Prior to the actual conversion, employees were concerned as to whether they would be able to meet the demands which the change would bring. This was a period of ambiguity and doubt. As soon as the company announced its intention to introduce EDP equipment, some employees began to question their ability to learn the new duties and to be apprehensive about their ultimate place in the organization. Others expressed a desire to "get going and get it over with."

During the transition when top management was beginning to spell out in ever greater detail the dimensions of the change through meetings of the key department heads and supervisors in each unit, employees became increasingly concerned. As top line personnel became more aware of the complexity of the task they had embarked upon and began to wonder about their own adequacy to handle this type of change, their subordinates sensed these fears and in turn became more anxious as to when they would be brought in on the plans, how they could actually assist in the transition, and how they personally would be affected finally.

Once the conversion actually got underway, however, the demands placed upon the employee were those he shared with his superiors and in contrast to the pre-conversion periods were primarily physical demands. Both worked overtime, both lived in an ambiguous, changing work environment, and both were asked to perform at a more rapid rate and in a more devoted manner than previously. While the manager spent his time in managerial meetings, the non-supervisory employee conferred with co-workers and with his supervisor devising solutions to problems unique to a transition period.

Management's decision not to assign any jobs on a permanent basis until the total change process had run its course was at once assuring and disturbing to many employees. The decision was necessary because the completed system was difficult to visualize. Employees recognized the good intentions implicit in this policy, but the continuing uncertainty was hard to live with month in and month out. When the policy was introduced, it was assumed that the change-over would be completed in a relatively short time—two years or three at the most. But as the transition period stretched out, this continuing ambiguity became a greater problem for both employees and supervisors, all of whom were looking forward to a period of system stability and equilibrium.

Employees were not only confronted with a relatively unstructured picture of their long range future in the company, but the immediate working environment for many was equally ambiguous. Those directly responsible for the introduction of the new system were without guideposts to handle this type of technological change in the office. The few companies with some experience in introducing EDP equipment had not attempted such a total system change. Some employees who did not even remotely understand the system that the managers were hoping to create found themselves in training for a job that no one had really seen in operation. Instruction during much of the change was necessarily at quite an abstract level; it is little wonder the employees expressed fears about learning the new required skills—particularly when their jobs were subject to frequent modifications on short notice.

During much of the change period, then, the employee operated on faith: faith that the demands that were placed upon him would be rewarded in the future, and faith in management's ability to effect the change.

After all company accounts were converted to EDP procedures the transitional period came to an end, and the organization was faced with the task of making the final assignments of personnel to permanent jobs in the new system. The policy which was formulated to handle this mass shifting of over 270 employees was dictated by a combination of existing circumstances, previous commitments, and the general management philosophy of the Accounting Division.

Nearly everyone, management and employees alike, had anticipated higher average job grades as a result of the change. However, these higher job grades did not materialize. The least interesting and the most menial types of jobs had been eliminated, but so had a number of high level non-supervisory jobs. Certain previous job grades in the Accounting Division had been somewhat higher than similar jobs in other parts of the organization, and for the first time in a number of years it was possible to bring these jobs into line with the rest of the company. Moreover, as might be expected, nearly everyone had at the outset overestimated the complexity of the new jobs because there had been no experience with them.

Since company policy was to avoid—insofar as possible—reduction in pay rates and job grades of permanent employees as a result of the changeover to EDP, the elimination of upper level jobs in particular greatly complicated the task of reassignment. Furthermore, earlier commitments to the permanent employees precluded one alternative of the usual selection process, i.e., total rejection of the candidate. The problem, therefore, was one of optimum placement of all employees in a manner that would minimize losses in terms of pay and promotion and at the same time enable the company to maintain a staff that was capable of operating the new, and often more demanding, system. These goals were often incompatible and compromises had to be made. Instead of the usual procedure of making assignments to maximize a prediction of success on the job, many personnel decisions had to be made within the framework of minimizing failure. For example, X was obviously the best man for Job 1; he was also the best man for Jobs 2, 3, and 4 that were open simultaneously. On the other hand, there was person Y who had to be placed and who could adequately perform on Job 1 but not on Jobs 2, 3, and 4. The placement of Y on Job 1 then became imperative even though he was not "the best man for the job."

From an overall company point of view, this approach of trying to find a best fit for all employees was quite acceptable. To the first line supervisor or department head, who later would be judged by the performance of only his own subordinates, the placing of known-risk candidates and the passing up of better candidates for jobs in his own group were more difficult to accept. It was all too clear that some of these assignments meant the department head and his staff would be saddled with such an employee for a long time.

As the reassignment program gained momentum, a review of those individuals who were difficult to place revealed that a few factors—such as age and physical disabilities—were the principal deterrents to a candidate's placement. It became apparent that the very nature of some of the white collar desk jobs which existed before conversion had attracted many individuals with physical disabilities such as speech or hearing difficulties, arthritis, or heart conditions. Many of the new jobs required communication with others including the use of telephones, standing at machines, and a considerable degree of training. Moreover, a large number of the jobs eliminated were at the higher levels—levels where one found the older members of the work group, many of whom had worked their way up on highly specialized jobs. Some of the most difficult jobs the company had to fill under the new system had to be staffed from a population that had the least potential.

The reassignment period was one in which several other changes were being made that demanded the careful attention of management. They were also directing all of the activities necessary to introduce a new customer bill form and to change the physical location of all departments affected by the innovation. A number of the interviewees noted that either one of these changes would have been highly disruptive, even "traumatic" to some people, at any other period. However, perhaps because of the magnitude and duration of the change they had just encountered and the personal significance that the reassignment process held for each individual, nearly everyone—management and employees—was able to take these other changes in stride.

Besides the stresses involved in having to accept high risk job candidates, there was the accompanying problem for management of training new members of the work group who were replacing already trained members. Unlike the usual job candidate who anticipates starting at the bottom and learning the fundamentals, the transferred employee often brought several years of seniority with him along with a set of status claims he was accustomed to having met. Even though it was expected that the transferred candidate would rapidly gain proficiency on the job, the necessary training on the elementary and often less challenging tasks of the new job resulted in situations that violated the candidate's self-image. Frustrations derived from such situations often severely taxed the supervisor's human relations skills. These kinds of problems appeared to be somewhat less difficult when two or more employees were transferred together. Several individuals could better face these new and frustrating roles as trainees in a new work group under a new supervisor if they could share and evaluate their experiences with others having a common background.

As the reassignment process started to affect personally the majority of the workers, more employees became visibly concerned about reassignments. Throughout the period of transition there was little disturbance or resistance until each change was imminent, and this again was true of the reassignment phase. Immediately after the job grades and reassignment plans were announced, supervisors reported that only a minority of the employees showed any signs of psychological distress. The earliest reassignments were made at the highest levels, and although many individuals were not accommodated as they had hoped, there was little change in the behavior of workers as reported by their supervisors. The reaction as reassignment of the middle job grades approached was quite different, however. One of the largest single groups of employees worked at grade 0–9 jobs. The week that the 0–10 jobs were being settled, supervisors began to report symptoms of nervousness and anxiety, lowered performance rates, and other indications of a generally agitated work force. A rash of rumors swept Accounting that week.

While no systematic records were kept, supervisors generally felt that an individual's performance went up again following a decision on his job assignment, whether or not the results were favorable for him. Several supervisors reported of their employees that the waiting for the decision seemed to be much worse than the result of the decision itself.

Throughout the latter part of the reassignment period there was a growing realization by personnel at all levels that the organization which was emerging was going to be quite different from the organization they had known so well before the change-over. There would be no going back to the old system and its comfortable, familiar routines. The new patterns of work flow and relationships which were being established contained the environmental realities to which supervisory and non-supervisory personnel had to accommodate. The following is a brief description of the new organization.

A change-over to EDP appears to accelerate the level of formalization within an organization. The organization of work is further rationalized; rules and regulations are substituted for individual decision-making. Programming itself is a large step in this direction. Decisions formerly left to individual employees to handle within the spirit of a general statement of policy are programmed into the machine. It is this type of decision with known criteria that can be built most readily into machine programs. With the programming of this area of decision-making, important functions and even certain positions within the organization are eliminated. Previously these functions have supported a job occupant's claim to a title and a grade of some status within the system. Such positions are typically perceived as status positions, serving as terminal points for the average employee who rises to these positions through sheer endurance within the system. Occasionally these positions also serve as a proving ground for managerial aspirants.

In this study the elimination of these status positions and the further restriction of the areas of employee decision-making fell as a severe blow on status position occupants. Long service employees were stripped of many of their responsibilities at a time when the right and ability to make such decisions was the principal reward of the job.

The new more highly integrated work process allowed less autonomy in setting a work pace for both individual employees and work groups. Work could not be held over from one day to the next. Each group had to process a specific number of accounts every day or perform specific operations. Deadlines themselves became more important, regardless of how the job had been going, or how the personnel and equipment were performing. Absences and tardiness became increasingly important because of their detrimental effect on the group's ability to complete their portion of the job.

Greater interdependence also resulted in greater vulnerability and a greater need for coordination. A breakdown in one phase of the work flow soon stopped the whole operation. Since a change in one section will quickly affect another's ability to do its job, new procedures and centers for coordination were required.

A different type of relocation of control also occurred as responsibilities for given areas or duties were transferred to other groups, departments, or divisions within the company. Throughout the change period there was evidence that such transfers of responsibility often resulted in the control moving either horizontally or to some higher level in the organization to effect a more efficient coordination. Since various sub-units contributed to different stages of the input, it was necessary that a central control unit be aware of any deviations that occurred. Consequently final responsibility and control was vested in a very few positions.

This shift toward more centralized control and decision-making was required to handle the new level of coordination necessary to maintain what was obviously a more efficient system. On the other hand, such centralization ran directly counter to the company's philosophy of participation—one of its principal objectives being the delegation of responsibility directly to first-line supervisors.

The new system resulted in many changes in job structure and in new and differing patterns of relationships. Some of the jobs that were eliminated were taken over directly by the 705. The new equipment also brought into being two major classes of jobs: programmers and electronic equipment operators. The greater number of key punch operators and other machine groups increased the number of employees who were associated more with the mechanical processing of the data than with the data itself. Because of the obvious distinguishing characteristics of the machine jobs as against the accounting jobs and because promotion is probably more feasible within rather than between the groups, there is an increasing possibility of a rather severe schism between these two groups within the Accounting Division.

Job enlargement does not necessarily accompany a change-over to electronic accounting. In this instance, however, it did. The work of the non-mechanized accounting groups responsible for the steps preparatory to the machine handling of the customer's account was completely reorganized. The specialized tasks previously done in five separate sections were consolidated into "a station arrangement," and each member of a station was trained to handle all five operations as a part of a new enlarged job. This reduction in job specialization resulted in increased efficiency in the allocation of man-power, and it is believed that most employees and their supervisors were more satisfied with these jobs.

In addition to creating new jobs and new combinations of old skills, the system required the development of different relationships. With the loss of autonomy and the introduction of more system pacing, groups became more highly dependent upon each other and individual responsibilities became more obvious and easily evaluated. Such changes allowed the development of tighter standards of performance, and the increasing costs of errors augmented concern for standards. In the sense that failures in performance were easily detected, the machine placed more responsibility upon the individual employee.

There has been little chance as yet to assess how this extensive period of change will affect the organization eventually, but we are able to indicate what some of the major effects have been on the organization and its members to date.

Accounting and Sales Divisions have moved from a relatively autonomous set of departments to a much more highly integrated system. The installation of electronic equipment has brought about changes in policies and procedures which are much more demanding of the individual employee. The level of decision making and control has moved up to fewer and higher positions within the organization. Changes in the job and promotion structure have been quite drastic.

For many individuals this was a period of growth; for others a period of failure and disillusionment. The change severely tested marginal employees and supervisors while at the same time giving more experienced and able personnel the chance of their life to develop and to demonstrate their work potentials.

The change period gave management at all levels a much deeper understanding of the human resources within their organization. It also increased each supervisor's awareness of how his responsibilities interlock and interrelate with other supervisors, superiors, and subordinates. The long period of sharing problems with other managers, and the need for extraordinary cooperation at all levels resulted in a greater appreciation and tolerance for other parts of the organization. Employees and supervisors learned to work together in problem solving groups in a way which neither would have thought possible before the change started. It is already apparent that the principal reasons for which this major organization change was undertaken are being attained; the new system is permitting a reduction in cost and is sufficiently flexible to encompass further expansion. The final effect on the individual members of the organization who were caught up and embroiled in this change is still to be learned.

5. SHOP CHANGES AND THE SECURITY OF THE INDIVIDUAL

From B. M. Selekman, "Resistance to Shop Changes," *Labor Relations and Human Relations*, McGraw-Hill Book Company, Inc., New York, 1947, pp. 111–137.

The following case illustrates the suspicions which can arise when a shop change is perceived by workers as a threat to their concepts of individual worth and security. . . .

A firm we shall call the Regent Company made a complete change-over of its production program. During the early 1930's, at the very depth of the depression, the company decided to shift its output from the low-quality, cheaply priced consumers' goods it had been producing for almost a quarter century to a quality product that would compare favorably with the best in the trade.

From an outside point of view the success of the company was truly outstanding. The business expanded, thus creating more jobs, and the company's product acquired a national reputation for high quality. The management at that point launched an active promotional campaign. Newspaper stories covered the new product. Buyers and other guests thronged the company's showrooms.

But within the shop community things were not going so well. There, frictions of all sorts followed one upon the other. Stoppages, slowdowns, sit-downs became at times veritably epidemic. And almost every one of these occurrences seemed to be caused by some proposed shop change.

Quite understandably, the shift from low-quality to high-quality production entailed many changes in the methods and organization of work. Employees had to unlearn old skills and acquire new and often more painstaking ones. The pressure seemed unremitting. The workers would complain, "The boss always wants something different and new; he always wants more quality." All this happened despite the fact that the officials of the union with whom the firm had been dealing for over two decades had cooperated from the beginning in the new production program. Consulted before the change-over and realizing that jobs would be made available to hundreds of their members if the program proved successful, they had given their approval.

Yet changes in method had to run up against stubborn resistances. For even though the shift in production overcame a grave danger to jobs during the depression, the rate of change was so rapid that it was a constant threat to the security system of these workers; affecting their ways of working, their earnings, and their group association. Because the changes were introduced not only rapidly but also erratically—without manifest plan or any pulse of regularity—their seeming threat was sharpened; the workers found no way of adapting daily performance in all its social and psychological complexities to eventual acceptance of innovation as an integral part of the quality program.

An established process of work that had been paid on an hourly basis, for instance, was subdivided into specialized operations to be paid on a piecework basis. The workers who were affected not only felt discomfort in the changes forced upon their customary operations but also feared that the different requirements henceforth demanded of each of them might threaten their group solidarity by instituting piece rates that would result in varying weekly earnings.

Again, every new method of work urged upon a worker or a group of workers seemed to mean possible losses in pay. The workers were impatient in their demand that wages rates on new operations be determined even before the operations had been adequately tested. Demands for rate increases constituted almost an unfailing response to a proposal for a change in methods of work, whatever its nature. Time and again, groups refused to go on until new rates were set.

New foremen appeared in the shops as management sought out supervisors experienced in quality production. To the workers each new foreman promised more of that unwelcome pressure to "do it different." They chafed, not only because this pressure disturbed their familiar ways of work, but also because it seemed to belittle their craftsmanship. Holding intransigently to their habitual methods, they expressed their resentful pride to the arbitrator: "We've been in this work a long time and we know our business." The new foremen, with their quality experience and their insistence on quality work, almost invariably found that the balky employees made their first months very rough going.

The workers resisted inroads against their structures of interpersonal relationships. Thus they were more sympathetic with the old-timers among their foremen, who, as they put it, could "also get a call-down now and then." Among themselves the employees coalesced into tight little bench cliques, which became their instruments of defense against the unnerving bombardment of change. Management was vividly aware of the presence and activities of these groups, without realizing the forces that generated and maintained them. "If we have twenty operations in a room," the manager complained, "we'll have twenty little groups, each with its own leader."

These groups developed a remarkable cohesiveness. Their watchword for action, as they expressed it and their supervisors echoed it, was always "one for all and all for one." They adapted their tactics to the nature of the change they were asked to absorb. Periodically—or, to put it perhaps more accurately, recurrently—they simply put on their hats and went home.

Management insisted time and time again that some way would simply have to be found to stop these illegal walkouts. The union officials and the permanent arbitrator for the industry were compelled to give considerable time to getting such strikers back to their tools.

Recurrent unauthorized stoppages constituted the most extreme weapon in the workers' arsenal of resistance but by no means the only one. The craftsmen, now doing one subdivided operation in the process each had formerly performed as a whole, spontaneously applied to themselves the principle of equality in order to safeguard their fellowship; even though under piece rates some naturally earned more than others, they pooled their pay envelopes at the end of each week and divided the aggregate contents equally. In the same cause of fellowship another group, composed of women workers on piece rates, equalized not earnings but the opportunity to earn; none would begin work on her materials until all were supplied. Many bench cliques likewise adopted an attitude toward supervisory criticism that reflected this "one for all and all for one" sentiment. If a member of such a bench clique was taken to task for not following new methods, his fellows joined in angry protests and ostentatious adherence to the old ways of working. And all groups jealously protected their identity; their members either refused outright to work with new assignees or subjected them to such ostracism that these newcomers themselves soon requested transfer.

It must undoubtedly appear amazing at first glance that such constant turmoil could coexist with an outstanding achievement in production. The explanation lay in the fact that the general manager actually enjoyed a basically good relationship with his employees as well as with union officials. The workers' service records ran from one year up to twenty years and over, with the majority of the force long-service employees; the very frictions which developed resembled family irritations exploding into protest and rebellion against an arbitrary but well-meaning father. In their calmer moments, even after a walkout, workers admitted that the boss really was "a good sort; he just loses his temper sometimes." And impatient as the union leaders might now and again show themselves with the general manager, they realized that he was an able businessman, not untypical in his failure to apply in human relations the same degree of skill he brought to production. To him his ends were good; they benefited workers as well as the company. He not only failed to understand the consequences of his means for achieving these ends in unremitting pressure on the workers; he was even outraged that union officials—and the arbitrator, too—did not enforce the agreement to free him from these "constant illegal stoppages."

For his part, the arbitrator served as a sort of safety valve when crises arose. Familiar with the many factors shaping behavior in this shop, he listened, as tensions reached a breaking point, to the complaints of union officials, management executives, and employees alike. Outside the area of "family" irritations, he refused to become overconcerned or overdisciplinary but handled each difficulty as it arose, confident that when the individuals involved had once more let off steam, they would return to the production of an outstanding quality article in their trade.

Thus the employees of this company revealed the disturbances that inevitably follow the threat to security systems sensed in any innovation, i.e., the threat to workmanship, compensation, and interpersonal relationships. Bench associations became tight little defense groups maintaining constant watchfulness and resistance within the ramparts of the security system. Yet a sound structure of over-all relationships among management, union, and men remained, so that the resulting turmoil became a kind of family friction rather than a bitter industrial conflict. Nevertheless, the errors of omission and commission that accounted for this friction highlight the inadequacies in industry's approach to the human implications of change—implications, moreover, that obstruct the very production goals sought by management. They emphasize vividly that administrators when planning new methods of work fail to make allowance for the emotions and sentiments that will be evoked in the workers who must accept the changes.

The problem of what to do about these feelings constitutes the heart of the task in adapting shop change into the structure of shop relations. In terms of the diagnosis here offered, two areas for action suggest themselves: (1) The *negative* feelings must be brought to conscious recognition and given acceptance as a normal response to a situation of change; moreover, reassurance must be provided against whatever prospect of injury seems to be felt by those involved. (2) The responses stimulated by these negative feelings must be turned into *positive*, constructive channels by utilizing such affirmative values as the change may possess.

Mitigating Negative Emotions. What concrete measures offer promise for mitigating negative emotions? Perhaps the first is *prior consultation.* Present-day discussion of such consultation confines itself to the pros and cons of union-management conferences on these matters. But consultation that stops with union officials, as it did in the Regent Company, can never be enough. Union and management both must consult the carriers of shop opinion and sentiment at all levels—the foremen and stewards, the bench leaders and their groups, the particular workers involved, and anybody else whom specific conditions may counsel. It is the imposed change that constitutes the feared change; consultation offers an antidote against the sense of imposition.

Talking it over, however, must be more than a logical exposition. Instead of concentrating upon talking men out of their fears, suspicions, or resentments by decrying them, instead of emphasizing the lack of logical basis for their fears, management must accept these emotions as the entirely normal and human response most men give in such situations. Even when the fears have some real basis, frank acknowledgment of this reality may prove helpful. The results may be painful, but men accept an unfavorable condition more readily if they are convinced that it is inherent in a situation rather than in an arbitrary personal decision, if they feel that everything possible is being done to cushion its impact. When fears have no real basis, when, for instance, a new incentive system of pay, a new process, or a job-evaluation study has been carefully and fairly formulated and no one is to suffer but rather all stand to gain, then talking things over relaxes tensions and dispels suspicions. Anxieties that are ventilated, accepted, and frankly discussed are likely to be relieved.

Introducing Changes Gradually. The proper *timing* of change constitutes a second important ingredient for reducing resistance. Too many new machines, too many new foremen, too many changes in methods or organization of work coming all at the same time or in rapid succession are certain to work havoc, as they did in the Regent Company. Time and again, the necessities of war expansions created parallel tensions among foremen and workers at the bench; the later reconversions to peacetime production introduced different but equally potent anxieties and unsettlement. When one innovation follows another, tensions sharpen, disturbances accumulate, and protest and resistance sooner or later result in stoppages or take on particularly stubborn forms of slow-downs. Indeed, as soon as we understand the emotional mechanisms that underlie the response to change, it is not hard to realize why the rate of change becomes an important component in conditioning response. The appearance of new demands and new threats before earlier ones have been met multiplies fears and hostilities and so intensifies resistance. Thus it is important to allow enough time for assimilation and adaptation.

An integral part of such considerations regarding the rate and timing of change, what we might term the "rhythm of change" requires the most alert attention. On the whole, management has acted as if changes are to be introduced whenever the time seems technically right for them, however whimsical and erratic the underlying decision may appear to the men who must assimilate the new methods. Yet unless shop change bears some manifestly planned relation to prior shop practice, including prior shop changes, shop operations bog down somewhere. We need, in consequence, systematic experiment and research into what constitutes the optimum rate of change in human terms—a rate that is adjusted to considerations of individual and group equilibrium by avoiding jerky, sudden and unprepared disturbances to work habits and associations.

Establishing Adequate Grievance Machinery. Just because change disrupts going habits of work, a well-understood *grievance machinery* fortifies against the sense of threat and danger. Systematic procedures represent a continuing and stable element in the midst of impending changes. The very knowledge that one can turn to such familiar procedures offers a source of security. Moreover, the grievances that stem from change, whether predominantly objective or subjective, yield clues to the type of resistance to be handled, provided the administrator has learned how to probe complaints. A simple, normal fear may lend itself to straightforward acceptance and reassurance; a more complex sentiment, expressed through bench organization, may require protracted treatment.

Evoking Positive Feelings. All the measures for handling resistance thus far discussed are aimed primarily at the negative emotions potential in change. But what about positive values that may be evoked to win actual acceptance rather than merely to mitigate resistance? Manifestly, positive values, too, must be focused upon the three elements that the worker feels are threatened by innovations: earnings, skills, and personal relationships.

Earnings. It need hardly be said that the administration of changes must be made as fair as possible. The management that finds ways of sharing gains with its workers through an opportunity for higher earnings and better conditions obtains thereby a very real incentive for the acceptance of the change. Certain changes, of course, inevitably entail drastic consequences for the workers immediately affected. In such instances it is futile to look for any positive values. But, at the least, adequate offsetting measures should be provided: separation wages, retirement annuities, retraining for new jobs, transfers to plants when work is available—all these and more must be part of management's program. No one can be made enthusiastic for a device that may put him out of business or lower his standing, even though in the long run the community as a whole may benefit. Whenever possible, therefore, workers should be helped to see a tangible, personal gain for themselves in any proposed change; when actual loss seems inevitable, some protections and compensatory programs must be offered.

Skills. How can positive sentiments concerning the securities in skills and workmanship be evoked? By its very nature, the engineering that advances efficiency erodes craftsmanship. The whole process of reducing costs, in order to make more and more goods available at prices the masses of consumers can afford, calls for a constant breaking down of rounded, complex skills into simpler repetitive jobs. Skilled craftsmen still hold very important places in production, but an ever-growing proportion of workers take rank as semi-skilled and unskilled. There is still need for the toolmaker and the patternmaker, but increasingly the machine and the assembly line dominate production. When this is admitted, how can the sense of workmanship afford a means of promoting positive support for new methods that are continually being developed? It is an old question that reaches to the very heart of a major problem in modern industry. Can workers be helped to see the significance of the seemingly detached minor tasks they perform in turning out the final product? Can men in industry feel the emotion experienced by members of a team, who also play individual segmented roles to achieve a common goal that has social value appreciated by the whole community? We must somehow recapture for workers their feeling of identification with the whole product their combined labor turns out.

Interpersonal Relationships. This simply means that in modern industry, with its division of labor, the satisfactions inherent in workmanship must be consciously tied in with those of good interpersonal relationships. The team as a whole, the working unit, alone can transmit to most workers the full creative satisfactions of work well done and of communal significance. Management must therefore give serious attention to discovering means for making each worker feel himself a part of the team.

The sense of identity with an institution, whether it be a combat unit, a school, an athletic team, or a shop, comes to fruition only when the individuals making it up share in the knowledge of the goals and of how they are to be reached, believe them to be worth while, and participate in the satisfactions of their achievement. Consider, for instance, the failure of the Regent Company in all these respects. Management never took the workers into its confidence regarding the purpose of the shift from low-quality to high-quality production or the necessary measures in daily operation; and then finally it shut them out from the satisfactions of success, taking credit alone for the achievement through its dramatic promotional campaign. The workers merely read press reports of the big doings; they saw visitors throng the showrooms; they noticed interviewers seeking out management representatives; they heard of various festivities. Not once were they even mentioned. Instead, while everybody else was celebrating, the ones whose labor had contributed so much to the occasion that was being celebrated were expected to go on with their daily grind and to do an ever better job. Since they were not made to feel that they were participants who also mattered, little wonder that they remained unreasoning obstructionists. The lesson is clear and can be summed up in a few words: Each company and each industry must somehow explore the possibilities for communicating to wage earners, both factually and emotionally, the purposes of the changes it recurrently asks them to absorb and also the pride in worth-while achievement through constant improvement in production.

Concluding Remarks

Resistance to change in the shop, then, confronts management with a problem that for all its serious import has not yet even received recognition, not to mention a willingness to experiment with measures for its treatment. Because they know that their ultimate objectives are right, the men who define their goal as the production of ever more goods at ever lower costs resent the interference of other men. Resentment, of course, is itself an emotion; it makes human resistance to shop changes seem like sheer human cussedness. The administrator then becomes hortatory and moralistic when he needs above all an open-minded willingness to approach human interference precisely as he does technical difficulties—as a problem to be studied and solved in terms of its causative factors. Resistance does have its causes; it stems from individual emotions and social interrelationships. The emotions are powerful, but they also are entirely normal. They must be accepted as the typical response of men faced with situations that seem to threaten their customary security systems. Yet change, too, must be accepted. If emotions are the dynamos of human response in social situations, change is the dynamo of technological production in industrial society.

Clearly, the problems of shop relations created by the almost invariable resistance to almost inevitable shop changes are complex, challenging, and inescapable. The unsettled conditions marking the period within which they must be tackled intensify the difficulty. Only *after* responsible administrators become aware of the true nature of the resistance will experiment and experience tell what may prove the most effective answer. Awareness must come first. Given that awareness, we may hope that the men who can master the most challenging technological problems will not bow in defeat to this parallel problem of human behavior.

6. EMPLOYEE PARTICIPATION IN TECHNOLOGICAL CHANGE

From J. R. P. French, Jr., et al., "Employee Participation in a Program of Industrial Change," *Personnel,* vol. 35, no. 6, pp. 16–29, November–December, 1958.

Several years ago the management of a well-known men's apparel manufacturing company decided to modernize its production methods.

Management was aware that the attitudes and feelings of the workers toward the change were a matter of prime concern. It therefore decided to encourage their participation in the change process as much as possible within the limitations of the situation. The workers had always manifested great resistance to any change in production methods. The decision to revise them was taken by management as part of its duty to keep the plants modern, progressive, and efficiently run. With rising labor costs, the introduction of labor-saving processes had become mandatory; otherwise, the company would not be able to maintain its competitive position. Its competitors had already begun to change their manufacturing methods, and were introducing a continuous-flow form of production in place of the older batch process.

In handling ordinary minor changes the management had firmly adhered to three principles, based partly on a recognition of the psychological factors involved and partly on legal considerations, inasmuch as these principles had gradually been incorporated into the pattern of labor-management relations over the years. The principles in question were: (1) Earning opportunities on the job should not be deliberately reduced for the purpose of adjusting rates which experience had shown to be too generous. In other words, management would carefully avoid actions that appeared to be any kind of disguised rate-cutting. (2) The worker should always be informed of an impending change in the job as soon as it was definitely decided upon. (3) If a change required relearning on the part of the worker, the cost of relearning should be borne wholly or partially by management.

In the case of relatively major changes,[1] it was management's belief that the workers should participate in the definition of the change to the maximum possible extent. Of course, this does not mean that management was prepared to abdicate its responsibility for the growth, development, and operation of the organization. Management alone decided to make the changes in question here and—as has been said—their general nature was determined by management with the help of its engineering consultants.

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[1] These, as the case shows, are not major in the sense of the larger technological revolutions described earlier.

What is to be gained from employee participation in a program of this kind? Above and beyond the general positive effects on morale and labor-management relations, two highly practical benefits may be noted. First, the technical program develops more rapidly. Any problems encountered by the workers are early brought to management's attention so that adjustments can be made with a minimum of delay. The workers' suggestions can be incorporated into the new procedure before a scheme of payments is fixed. Through participation, it is possible to head off any misunderstandings that might arise. This helps to avoid any deliberate obstruction of the new system by the workers.

The second advantage of having the employees participate is that the new method becomes the brain child of the workers themselves. Its success gives them a feeling of pride and accomplishment. Their very desire not to fail at their own project exerts a major influence on its success.

Participation is also a form of communication. When a man's job has been changed, some of his skill becomes obsolete and it is easy for him to view management as frustrating him, and as unjustly and even hostilely cutting his earning opportunities. If management's reasons for the change are not hostile but are actually for the good of all concerned, the worker's participation in planning for the innovation is an appropriate way of explaining it to him and letting him know the real reasons for it.

One form of participation is interactive discussion between management and the workers. This type of discussion gives management the opportunity to communicate and to be challenged at the same time. Of course, where communication is only one way and the workers merely listen politely, no participation takes place at all. A minimum requirement of participative discussion is that the workers should ask questions and that management should answer them in a straightforward and honest way. Furthermore, the workers must feel free to raise important issues—questions that are perhaps impolite and that recognize the possibility of conflict between management and the workers. Discussions are not participative if the workers have no real opportunity to speak up. It should be added that "opportunity" in this sense is not merely a matter of providing adequate meeting time coupled with a polite request for questions. Management must deem it proper for the workers to ask hard questions at such meetings—and the workers must have the assurance that no reprisals will be taken against frank discussion. (In passing, it may be suggested that participation may perhaps be more readily obtained from workers in unionized shops because the employees feel that they have the union to fall back on.)

Admittedly, interactive discussion is a minimal form of participation.

Naturally, it is better to have the workers actually share in designing the change, if this is possible. When, as in this case, the nature of the problem calls for skilled engineering, employee participation must necessarily take a more limited form.

Nevertheless, the main benefit of participation can be achieved even when there are practical limits as to how far the employees can actually contribute to the change. The goal is to have the workers feel that they are truly part of the company, that in some sense it is their enterprise as well, and that they are as dependent upon and responsible for its success as management is. But unless management really believes that the workers have such a place in the organization, it is extremely difficult, if not impossible, to communicate this message to them. Management must begin by considering the workers to be an integral part of the enterprise. This is a basic condition—without it, participation cannot be attained.

How the Change Was Introduced

At the outset, the precise changes to be introduced in the re-engineering of the production lines were not known; these were to be worked out experimentally within the plants. The methods proposed were as yet unproved; nevertheless, they offered great promise, and it was decided to develop them in the two smaller plants first. This strategy was based on various considerations—some technical, others having to do with employee morale. On the technical side, simpler and more standardized items were produced in the smaller plants. Since these two plants accounted for a smaller proportion of the firm's total output than the large plant, less risk was involved should serious production delays be encountered during the change-over. It was also felt that there was more personal communication between management and workers in the smaller plants. Furthermore, since the large plant had intra-union difficulties, the small plants were considered less sensitive places in which to try out the rather fundamental changes contemplated.

Group Meetings

The program was introduced to the workers by a series of meetings. Each group of operators performing the same operation in the same plant met with the local plant management. In the course of the program, approximately 80 such meetings were held, the number of workers attending varying from one to eight. When there were only a few workers on a particular operation, they were accompanied to the meeting by the shop steward.

At the first meeting, the proposed change in methods was announced and its general objectives were stated. Emphasis was placed on the need for the change and the importance of the program to both the company and the workers. The relationship of the company's success to steady employment was pointed out. No technical details were presented at this time, but the workers were assured that while the new methods were being developed their incomes would continue at the average level of the preceding six weeks. They were also told that when the new system was working well enough, new rates would be established and that a subsidy fund was being set up to help maintain their incomes until their skills were fully readapted. Frank discussion of these matters by all participants was encouraged.

Immediately after the initial meeting, things began to happen on the production floor. Machines were moved; new devices and small carts appeared. Experts gave demonstrations and instructions to individual workers in the new procedures. Engineers and supervisors watched, asked questions, and answered them. This gradual and outwardly tentative introduction of the changes was a deliberate policy. Only a few workers at a time were given revised tasks. Usually, it took several weeks before the whole garment was being made by the new methods.

Problems were solved as they arose. Many informal discussions of the new methods took place between engineers, supervisors, and workers. As the new methods were mastered, additional changes were made, sometimes at the suggestion of management, but often at the prompting of the workers themselves.

After the new system had been in effect long enough to be stable and was operating with some smoothness, another series of small group meetings was called to discuss revised wage rates. Separate meetings were held for each group of workers who were doing the same job in the same plant and who would experience the same changes in rates and the same revision of work procedures. After the workers were thanked for their help in developing the new system, they were given an explanation of how a time study had been applied to their jobs, along with the time allotted for each part of their operation. Time studies had been carried out on both the old and new systems, and this means of arriving at standards of time and pay was fully explained. While this technical discussion may have been beyond the understanding of many employees, its primary purpose was to show that management was not trying to hide anything, and that a rational method had been used to determine the new rates.

The Subsidy Program

At these meetings, management also said that the new rates would go into effect shortly and that the subsidy program promised at the first meeting would now start. The initial subsidy ranged from 10 per cent for those jobs which involved only minor changes to 65 per cent for those with the greatest changes. These amounts were decreased by 5 per cent each week until the subsidy ended.

In addition to protecting earnings during the readjustment period, the subsidy was also an indication of management's opinion as to how fast workers should recover a normal level of productivity after the disturbing effect of the change. The gradual reduction of the subsidy and its eventual termination were intended to provide a financial incentive for the workers to regain their normal production as soon as possible.

Many operators expressed satisfaction with the new rates. Some quickly did enough work in one day to attain their expected earnings. Others had obviously been holding back their production until the new rates were announced; when they saw that their earning opportunities had been protected and preserved, they, too, quickly recovered their former level of productivity. Although there were some expressions of dissatisfaction with the new scale, discussion of this was postponed until after the subsidy program had been given a chance to operate.

The workers also raised a great many complaints at these meetings, not all of which had anything to do with the new system. There were complaints about equipment, inaccurate cutting of parts, and other mechanical difficulties which are regularly experienced in factories. Management listened carefully and promised to investigate. This pledge was kept and the difficulties were subsequently remedied. (In a sense, these complaints were a favorable measure of the extent to which management was able to create a participative atmosphere. The workers did complain; they accused management of many shortcomings, and management on its part accepted the complaints as matters that merited its attention.)

The meetings at which the new rates were announced were the last such get-togethers for most operators. However, management continued to hold individual consultations on the production floor and to listen attentively to complaints. Problems and difficulties presented by the new methods were talked over and ironed out. A senior operator was given the job of interviewing other operators to find out what problems they were having and how they felt about the change. Through this channel management became aware of some technical problems that had not been raised at the meetings or during those times when its representatives were available on the production floor. By taking the initiative in establishing communication with the workers involved, management was able to solve these problems also.

After the new system had been developed and refined in the smaller plants, and the workers there were well on the way to reaching their former level of productivity, the change was finally introduced into the third and largest plant. The same methods of introducing the change were used here, but by now, of course, management was able to point to many examples of proven success with the new methods in the smaller plants. Development work in the third plant was limited to conditions arising from the manufacture of the many special items produced there. The whole change was carried out much more rapidly than in the other plants because the best procedures had already been worked out and most of the rates had been set.

Reactions to the New System

After the rates were announced, there were two instances where a few workers tried to prove them unfair by deliberately restricting production. But most of the workers responded well to the innovations, gradually raising their output to satisfactory levels. In the two cases of deliberate restriction of production, a satisfactory recovery of output has not yet been achieved. These involved two machine operations performed by groups of four and six women respectively. One operator in each group made a satisfactory recovery. It is worth noting that each was the only one in her group who had thought the rate was fair when it was proposed. Though these two women were able to resist considerable group pressure on them to hold down their production, their successful examples were insufficient to win over their co-workers to their point of view. Management finally had to make adjustments on these rates so that its policy of maintaining earning opportunities might not appear to have been contradicted. The benefits of these adjustments have also accrued to the two productive operators, but at this writing the others are still limping along, still convinced that the new system has drastically cut down their earning power.

These two very similar instances were about the only ones in which the new method was not accepted. While they were only a small flaw in an otherwise resounding success, they emphasize the importance of the proper initial presentation of a program of change, and show how firmly people cling to their original reactions to it.

There were, of course, noteworthy examples of a happier kind. Thus, the job of an older worker with almost 10 years' experience under the old system was completely changed, and for a long time her attitude was one of discouragement and hopelessness. However, thanks to the correct engineering of the rate for her new job, coupled with continuous attention and encouragement from her supervisor, and a substantial relearning pay adjustment, her job improvement was constant. A year later, her earnings were higher than ever before and she was able to look back on her period of hopelessness with equanimity.

In any such change as this, the engineering problems are so complicated that it is impossible to present a uniform picture of future experience to the workers. Some will meet genuine difficulties, others will find difficulties where none exist; some will be better off, and some but not all of these will know that things are better. The success of the whole operation depends upon the distribution of these partly psychological assessments. If management has been honest, has done its computations fairly, and spoken openly, there should be enough successes to carry the operation to a good conclusion. Otherwise, difficulties and negative reactions will be so widespread that the entire project can result in failure.

Quantitative Summary

There were several quantitative evidences of the success of the program described above. Productivity increased as shown in the table printed below:

TABLE 1. AVERAGE PRODUCTION BEFORE AND AFTER RE-ENGINEERING

Worker group		Average production in standard units	
Plant	Item	Base period	One year later *
1	A	79	76
2	B	67	75
3	A	79	80
3	B	69	75

* The base periods differ for the several groups, being the six weeks just prior to the start of the change. In each case, the one year later is the same six-week period of the next year.

Turnover and absenteeism both decreased.

The number of grievances, although larger, was not excessive in view of the very large number of rate changes introduced.

General Summary

The radical change in production methods described here brought about results that were highly gratifying to management. The cost of production was reduced; a better product was turned out; production time was shortened; and productive capacity was expanded without heavy overhead charges. Since the plants were highly engineered before the changes were effected, these gains cannot be attributed to any lack of efficiency earlier. These were substantial accomplishments which taken by themselves certainly justified the program. However, the achievements in the company's labor-management relations were also highly gratifying. To management the minimal nature of the difficulties met with during the change was at least as noteworthy as the economic gains. Indeed, the company's heads believe that the economic success could not have been obtained without the accomplishments in labor-management relations.

In addition to a sound beginning in production engineering, management attributes the program's success to the policies which it followed with its employees. These might be summarized as an honest attempt to maximize the participation of the workers in the change. Management considered the workers as part of the enterprise, with an interest in its success, and with the right to expect fair treatment. Hence management's plans were disclosed as early as possible before unfounded rumors got started, the workers' ideas were given attention, and their problems with new methods were investigated. In addition, their earning opportunities were protected and any economic loss brought about by the new methods was properly compensated for. Moreover, management was careful not to inspire resistance to the change by any action which appeared to be provocative.

Throughout the whole process, management did not lose sight of its right to make the changes it contemplated, but it was equally aware of what the changes meant to the employees.

7. FEARS ABOUT AUTOMATION

From A. H. Raskin, "Fears about Automation," *The New York Times*, Apr. 7, 1961.

The computers that are the brains of automation can perform a hundred thousand tasks, from rolling steel to deciding how many frankfurter rolls a bakery driver should leave at a Third Avenue delicatessen on a rainy summer Friday.

They design in an hour a new chemical plant that would take a platoon of engineers a year, monitor space vehicles on their way to the moon, coach baseball players, govern switches and signals on 35,000 miles of railroad track from a single remote-control center, collect eggs in electronic henhouses, refine oil, issue insurance policies, operate acres of industrial machinery and provide the guideposts for billions of dollars in corporate decisions.

One thing the computers cannot do, however, is tell how many workers have been added to the nation's hard core of unemployment by the technological progress they so strikingly exemplify.

They are equally incapable of forecasting how fast future displacement of manpower will occur as our expanding work force moves toward push-button factories, robot-run marketing, communications and transport systems and what may become a cashless, checkless financial network, in which your thumb before a scanning machine will be as good as a bank draft or credit card.

This uncertainty about what automation will do to people has befogged consideration of the vast range of things it will do for people. From the executive who finds a data processor making more reliable judgments than he on bringing out new products or putting up new plants to the factory hand jolted out of his job by an automated assembly line, the problem of man versus machine is currently more absorbing than all the promise of a more fruitful economy the new technology holds.

Government agencies, labor and management have assigned priority to a search for ways to cushion the human toll of this second industrial revolution. Their search is spurred by fear that, for many industries, extinction will be the price of failure to automate.

Indeed, many White House officials share the conviction widespread among industrial experts that the United States is moving much too slowly in availing itself of the advances that new equipment permits in efficiency and economic growth.

While Western Europe and the Soviet Union encourage maximum use of automation through institutes, research laboratories and pilot plants, our own investments in new plant and machinery have been declining since 1948. Testimony given to Congress by Dr. Walter W. Heller, chairman of President Kennedy's Council of Economic Advisers, indicates that two-thirds of our productive equipment is now obsolete.

Without speedier replacement of this aging capital stock, foreign producers are virtually certain to capture a bigger share of the global market that is the gateway to higher living standards and fuller use of our underemployed human and material resources.

Nevertheless, the tendency to identify automation with job annihilation, rather than economic rejuvenation, is holding back orders for automated machine tools that would help pep up business, cut military costs and ease the immediate high level of joblessness in the heavy goods field.

That is what John Diebold, the 34-year-old management consultant, who has become one of automation's high priests, recently told a House Labor subcommittee investigating the manpower impact of technological change.

His complaint was based on word that the Pentagon had vetoed plans by procurement officials at Wright Field, Ohio, to order $40,000,000 in electronically controlled machines for making missiles and war planes. The ostensible reason was that the Defense Department should not foster automation when millions were unemployed.

NO JOBS FOR THE UNSKILLED

This highlights a cross-pull as vexing as any involved in achieving the most socially beneficial mix of automation's blessings and burdens. The economic expansion essential to a durable recovery depends on an upsurge in industrial efficiency at rates far above those of the Fifties.

Yet the more rapidly we automate to achieve that upsurge, the harder it is likely to be to find enough jobs for the unskilled and semi-skilled manual workers who already represent the most sizable element in the pool of surplus manpower that began accumulating long before the present recession.

So worried is organized labor lest these workers become permanent sacrifices on the altar of industrial efficiency that union leaders have demanded Federal action to stop automation from developing into a "hideous Frankenstein" destructive of human welfare. The same worries over job security have increasingly found expression in strikes and strike threats.

What makes decision difficult on how best to harmonize the requirements of full efficiency and full employment is the lack of solid information on either the pace or manpower consequences of the shift in technology.

A further imponderable is whether we can eradicate the chronic slack in the economy that has made us increasingly unable to find uses for all the productive capacity we now have. Labor sees little urgency for raising output per man-hour when our present output tends so regularly to outstrip demand, even in prosperity.

Unions note that, before the recession took its sharp bite out of factory jobs, the number of blue-collar workers in manufacturing fell by 1,500,000 in a six-year period. More steel was poured last year by 460,000 production workers than 540,000 had produced ten years earlier. The list could be extended indefinitely—up and down the industrial ladder from 40,000 elevator operators displaced by automatic lifts in New York alone to 200,000 aircraft workers dropped in the shift from planes to missiles.

Labor insists that all this is merely the beginning. Its leaders talk gloomily of voice-controlled automatic typewriters canceling the jobs of 1,500,000 stenographers and of factories that will make automobiles, washing machines, television sets and fountain pens with only a handful of supervisors to stare at the self-controlling controls.

The ultimate horror in labor's book was an announcement that a computer, scheduled for delivery this fall, would be so versatile it would need a battery of satellite computers, many of them hundreds of miles away, to feed it enough data to keep it busy solving the problems of business and government.

"They say this computer will do the work of seventy-five of the biggest computers now in use," one awed unionist murmured. "When computers start creating unemployment among computers, it's really time to start worrying."

The only consolation he could find was the manufacturer's assertion that the new computer could simulate the entire United States economy to measure the total effects and implications of alternative economic policies. The union chiefs observed tautly that maybe then the machine could tell how workers could maintain peaceful co-existence with it and the rest of the electronic family.

Such appraisals irk industrialists, who say the "obituary accounting" approach to automation ignores the fact that its primary benefit is likely to be in extending the boundaries of men's knowledge and enabling them to perform jobs that could not be done at all without automatic data processing.

NEW FUNCTIONS FORESEEN

Among the trail-blazing functions foreseen for new super-computers is the monitoring of traffic on a vast complex of highways, with street signals reset to cope with minute-by-minute changes in congestion. Long steps forward in instant-access medical, legal and scientific research are in prospect. So is an overhaul of income tax auditing, under which Uncle Sam might automatically get a record of every dollar every citizen received each year.

Large employers in both the white-collar and industrial fields say they expect few wholesale lay-offs in the transition to new methods. They insist that the potential manpower savings are far less spectacular than prophets of the "Buck Rogers school" imagine, that much of industry will never lend itself to effective automation and that most of the cuts will be handled through transfers and normal attrition.

They note that half the prerecession shrinkage in factory employment was offset by a rise of 700,000 in the number of professional, white-collar and other salaried workers. This, they contend, will be the future pattern —a gradual movement away from sweat and drudgery to better-paid, more skilled jobs involving greater alertness and less strain on the muscles.

The really tragic technological displacement, in industry's view, occurs not in the companies that make technological improvements but in those that do not: thus losing their ability to compete and sustain any jobs.

NOT MUCH UPGRADING

Studies by the Federal Bureau of Labor Statistics of automation's effects in an airline, a bakery, an oil refinery, an insurance company and a television factory showed few workers discharged but relatively little upgrading.

Prof. James R. Bright of the Graduate School of Business Administration at Harvard University, who has done years of research in automated plants, finds little support for the notion that any substantial number of skilled workers will be required when automation really takes hold.

Many who share his skepticism about the extent to which electronically controlled plants will require manpower in anything remotely approaching present complements believe that inertia may prove the economy's chief safeguard against a precipitate aggravation of the unemployment problem.

Engineers engaged in persuading business men to automate report that so much time elapses from the time an initial policy decision is made until it reaches the action stage that much personnel planning can be carried out.

TWO HEADACHES REMAIN

However, this still leaves two giant headaches. One is what kind of retraining to give the workers who must be laid off when there is little trustworthy information about what kind of new skills will be needed—where, when and in what volume.

The other is what to do with the 1,350,000 new entrants who will be cascading into the job market each year for the next decade. Even if the bulk of the shake-out of present jobholders is made through deaths, retirements and other factors of normal turnover, the contraction of work opportunities will bear cruelly on youngsters looking for their first job and the millions now unemployed who wait for the recall signal.

In this sense, the real displacement on industry's new frontier may be much less among those discharged than among those never hired. This prospect is heightened by the reserves of efficiency expansion already built into our economy but unused because of the torpor of the market.

Most experts are convinced that, with business revival and a more vigorous demand for goods, it will be possible for the first time to cash in on the untapped potential of much automated equipment now in place. This implies that output could be increased by the equivalent of several hundred thousand jobs without a single extra worker punching a time clock.

All this complicates the mission of training new workers and retraining old ones. The Labor Department has made its own projections of where more workers are likely to be needed and where they won't, although the statisticians who prepared the figures acknowledge that they are as much guesses as probabilities.

The predictions call for construction and finance to swell employment at a pace much faster than the 20 per cent growth in the labor force anticipated in the Sixties. Government jobs, retail and wholesale trade and other service industries are also expected to keep ahead of the population explosion in their need for workers, but not as much ahead as the first two fields.

FARMING LAG TO CONTINUE

The most conjectural of the forecasts is that, despite the forward push of labor-saving technology, the development of new products and the expansion of living standards will cause factory jobs to go up at roughly the same rate as the work force.

Transportation, public utilities and mining are expected to lag and agriculture will continue to show a dwindling manpower need. The sum of all these expectations is a belief that at least 5,000,000 new skilled craftsmen will have to be trained by 1970, with the strongest need among repair and maintenance mechanics and construction machinery operators.

Engineers and technicians also will be in demand, along with scientists and research workers. The upgrading task will be a difficult, and perhaps impossible, one for those whose education and general background do not fit them for skilled work. The outlook is especially bleak for miners, laborers and other unskilled workers over 40, who already make up such a big chunk of the hard core of joblessness.

How to guarantee that our march toward a brighter future can be made without asking such workers to pay a disproportionate part of the price of progress is the challenge bedeviling our industrial society.

8. CHANGE AND THE FUTURE

From Charles Frankel, "The Third Great Revolution of Mankind," *The New York Times Magazine*, Feb. 9, 1958.

The first change came when man the hunter became man the farmer. The second came with the machine. Now the satellite symbolizes a new "age of acceleration."

Probably no event in recent years has had a greater impact on the American mood than the Soviet Union's success in launching artificial satellites. The sputniks stirred justified anxieties about America's position in the cold war and upset some of our tenderest assumptions about our situation. But more than this, the sputnik's—and now our own Explorer—have turned loose some bewildering predictions about the future.

Trips to the moon and twenty-minute jaunts to Moscow, we are told, are on the agenda of human "progress"—though no one has yet said how to make the moon or Moscow more attractive places in which to land. It is even whispered that mankind may lose one of its oldest topics of conversation because it will be possible to control the weather.

But while predictions about man's future career in outer space have an undeniable interest, the satellites, it may be suspected, also have a significance that is a bit closer to earth and closer to home. For they are not merely events in an armaments race or science-fiction stories come true. They are peculiarly dramatic symbols of what has been going on backstage, East and West, during the last fifteen years—a sudden extension of scientific intelligence and technical resourcefulness which represents an extraordinary spurt of human intellect and power. And this spurt of the human mind has social and moral, as well as technological, consequences. The sputniks are signs in the skies that the normal human scene is changing in some of its fundamental characteristics and that we are living in the midst of a fundamental revolution in human affairs.

Some 25,000 years ago an "Agricultural Revolution" took place which changed man from a nomadic hunter and berry picker into a deliberate cultivator of his food supply. In the latter half of the eighteenth century an "Industrial Revolution" began, with results which we have not yet fully absorbed. Both these revolutions began as changes in the ideas and tools men had used to adjust themselves to nature. They ended by changing men's relations to each other, their moral and political outlooks, and the very substance of the things they thought worth seeking in life. It is easy to overestimate the significance of events that happen in one's own day. But the revolution that has taken shape in the last fifteen years must be put in company like this to be seen in its proper perspective.

Indeed, in the natural energies it has released, and in the speed with which it has done so, the present shift in the relation of man to his environment dwarfs either of its predecessors. It is impossible to believe that its other consequences will not eventually be as great. Now that we have had a chance to absorb the first impact of the sputniks, it may be worth while to sit back and reflect on some of the long-range social issues of which the sputniks are a portent.

We can already see some of the more obvious issues. War, for example, has changed its character and has lost one of its traditional functions in international affairs. Leaving all issues of morality aside, large-scale war can no longer be used, as it has sometimes been used in the past, as an intelligent instrument even of national selfishness. While the danger of all-out nuclear war has not substantially receded, such war can only be an instrument of utter desperation.

Similarly, the problem posed by the expansion of population in the world promises to become even more acute as a result of the advances in medicine and technology that are almost surely in prospect. Through most of its history the human race has had to struggle to keep its numbers from declining. But our very success in improving the basic conditions of human existence now threatens to turn back upon us and to lead to incalculable human suffering unless organized measures are taken to control the birth rate.

But war and the growth of the world's population are relatively familiar problems, even though the penalty for failing to solve them has suddenly become astronomically high. The present revolution in human affairs is likely to bring other changes, however, to which somewhat less attention has been paid. And not the least important is a possible change in the way in which human work will be organized with the advent of new industrial processes such as automation.

One possible consequence of automation, for example, is a sharp increase in the ratio of skilled workers to unskilled workers. This means a host of new issues for industrial unions, and new problems for both labor leaders and industrial managers. Of equal significance is the possible impact of the automatic factory on the way in which the working day may be arranged. As the British engineer Landon Goodman has pointed out, the cost of introducing automation may be so high in many cases that it will be uneconomical to operate a plant only eight hours a day. If many industrial plants are going to find it necessary to operate around the clock, obvious consequences will follow for everything from the nature of home life to the way in which cities are organized. Even the old phrase, "as different as night and day," is likely to lose some of its force.

The new way in which work may be organized also affects the attitudes that men may take toward other parts of life. Most of the work that men have had to do in history has been disagreeable: most of the leisure that men have had has been the prerogative of the few. This fact has colored much of our thinking about the way in which life ought to be lived. The democratically-minded have been suspicious of what is "useless"; the aristocratically-minded have regarded the useful as just a bit vulgar. But if leisure becomes everybody's prerogative (and problem), and if automation can be used to make human work less routine and to give more workers the opportunity to exercise their individual skills and discretion, the sharp division between work and leisure will make even less sense than it makes today. The effects will be felt, to take only one example, in our ideals of "liberal" education, which are still primarily leisure-oriented, and in our conception of "vocational" education, which is already anachronistic in its view of what ordinary people need to be "prepared for life."

But the new processes of industrial production are parts of a larger trend which has even deeper implications of its own. During most of the past, developments in technology were largely independent of developments in pure scientific research. To some extent this remained true even in the nineteenth century. But technology has now become almost entirely the child of fundamental theoretical inquiry. This means that we can count in the future on a steady process of technological innovation, and at a steadily more rapid pace.

We come at this point to perhaps the profoundest consequence of the present revolution in human affairs. It is the simple change in the tempo of change. For nothing cuts more quickly or deeply into a society's way of doing things than changes in its technology.

This quickened tempo represents an unprecedented challenge to the human ability to adjust to social change. It took man roughly 475,000 years to arrive at the Agricultural Revolution. It required another 25,000 years to come to the Industrial Revolution. We have arrived at the "Space Age" in a hundred and fifty years—and while we do not know where we go from here, we can be sure that we shall go there fast. Our expectations of change, and the ability of our nervous systems or our social systems to withstand the shock of change, have been formed in the long experience of the race. And this experience, even in the nineteenth century, has not prepared us for the pace of events that lie ahead.

Such an extraordinary change in the basic tempo of human history means that new and deliberate efforts will be needed to control the processes of social change. As the last hundred years of Western history demonstrate, men can learn to change at a much quicker pace than before. But as these same years also suggest, there are limits, and it is difficult to imagine a day when it will not take time for men to adjust to new conditions, to learn new skills and habits, and to get over the nostalgia and resentments that come when old and familiar things are destroyed. There is a conservative in every man and, in the world into which we are moving, he is going to get a harder workout than ever before.

Accordingly, if the things we cherish from the past are not going to be carelessly destroyed, and if the best possibilities of the future are going to be realized, it seems probable that we shall have to have institutions that have been deliberately set up to exercise long-range social forethought. A steady process of technological innovation, for example, can mean recurrent crises of technological unemployment. If this is not to happen, institutions will have to exist to envisage the new skills that will be needed, to undertake the continuing task of retraining workers, and to control the pace at which new techniques are introduced so that we can make a sensible adjustment to them. Given the pace and magnitude of the technical changes that are in prospect, we cannot count on the market place and the price system to do this job alone. Technological innovation means social change; and there is no more reason to introduce such innovations, letting the chips fall where they may, than there is to introduce a new and powerful drug on the market without first making it meet the test of medical examination and control.

The need to exercise more deliberate control over the processes of social change raises, of course, a fundamental issue. It is the issue of freedom and regimentation, the question of the tension between personal liberty and initiative on the one hand, and the obvious and growing necessity, on the other, for an ever larger degree of social organization. This has been the central issue in industrial society for more than a century. In the world which the present revolution is forming it will be equally decisive. But the terms we have habitually employed in trying to solve it will almost certainly need to be revised.

The dangers that a larger degree of social organization can bring are obvious. It can mean, at the very least, a multiplication of the nuisances that exhaust individual energy—administrative forms to fill out, incessant committees, petty bureaucratic tyrannies. It can mean that power will steadily pile up at the center until it is impossible to place an effective check upon it. Perhaps worst of all, our ideals and attitudes can change.

Under the pressure of the need for organization, we can come slowly but painlessly to like the standard and the impersonal, and to prefer the man who fits the system to the man who is difficult to harness. If this happens, we can lose liberties we now cherish and never notice or regret the loss.

But the individual can be crushed just as easily in a subway rush as on an assembly line. When there is more traffic on the streets, more controls are necessary. And when these controls are inadequate or break down, the individual has less freedom to go where he wants to go, not more freedom. The question, in brief, is not whether we shall have a larger amount of conscious social organization or not, but what kind of social organization we shall have. It can be centralized or decentralized; it can be broken up into small units or cover only very large ones; it can concentrate authority up at the top or spread considerable authority down to lower levels. Most important of all, it can have as its conscious object the cherishing of individual differences and the promotion of individual talents. The dangers of a larger degree of social organization are unmistakable. But disorganization will be no healthier a climate for freedom.

The problems of social organization and of controlling the results of technological innovation bring us, however, to a final problem. It is the problem of the use and abuse of science, a problem that is likely to become steadily more acute as our world becomes more steadily and obviously a creature of science. In the future, as in the past, two extreme possibilities confront us. The first is to make an idol out of science. The second is to denigrate its importance on grounds of fixed moral or religious principle.

Illustrations of the tendency to make an idol out of science have suddenly blossomed all around us since the sputniks began their dance in space. With a hopefulness that is somewhat frightening, both scientists and laymen have predicted, for example, that science will soon be able to change human emotions and desires by biochemical means. Others have talked about the coming mastery of the principles of "group dynamics" and the ability that science will give us to choose the right leaders and to get people to work together harmoniously.

Such predictions represent revivals of Plato's ancient dream that, if philosophers became kings, man's political and moral troubles would come to an end. And they rest on precisely the same combination of political innocence and moral arrogance. There is, unhappily, no guarantee that those who dispense the pills that are going to change our desires and emotions will themselves have the right desires and emotions.

But it is a grave mistake to dismiss science as useless in solving moral and political problems. Objective knowledge of the conditions and consequences of our personal desires or our social institutions does help us to realize the actual nature of the ends we choose to pursue; and in this way we can frequently come to choose our ends and ideals more intelligently.

Even more than in the past, the world which the present revolution is creating will be one in which a process of steady re-examination of existing institutions will be a condition, not simply of a decent life, but in all probability of survival as well. Those who take fixed positions in such a world, and who deny the usefulness of scientific knowledge in resolving moral and political dilemmas, will be pleading merely for the rule of dogma or of their own private intuitions. It is unreasonable and unattractive to think that the society of the future should be ruled by a scientific élite masquerading as moral experts. It is equally unattractive to think that it should be ruled by those who make a principle of ignorance, and whose claim to be moral experts rests on their sense of superiority to the processes of sober scientific inquiry.

PART THREE

TECHNOLOGY IN NON-WESTERN COUNTRIES

INTRODUCTION

The subject as suggested by this part heading is broad enough to fill many volumes. Unfortunately, little of what has been written meets the criteria for useful selections, which are, for example:

1. That the selection treat the subject concretely rather than in generalities
2. That it be the result of first-hand field research by a competent observer
3. That it focus upon the problems of technology in underdeveloped countries, rather than upon the general problem of economic or political development or on specialized topics such as foreign aid, technical or military

For these reasons, the author has undertaken to present his own condensed survey of the field with commentary. Four selections follow this presentation. One is a case study of a factory in Guatemala, not a "Non-Western" country. But this and the other three selections make important contributions to the problem of economic and cultural adjustment to modern technology.

All over the world industrialization and technological change are on the march. They are tied to the national ambitions of countries emerging from colonial status; they are pushed as weapons in the global rivalry between communism and the free world; and in the hearts and minds of millions in the underdeveloped countries, technological advance has become dangerously close to a utopian cure-all for the accumulated social and economic difficulties of centuries and the explosive new problem of population growth.

Conflicting theories on how best to initiate and control economic growth absorb the world's economists. Anthropologists, psychologists, and experts in all the social sciences debate and study the human problems that, somewhat belatedly, are acknowledged to be an inevitable by-product of rapid technological change. Fortunately, the simple-minded formula, too long influential in American foreign policy, that equated economic advance with "stopping communism" appears to be on the way out. It is now recognized in thoughtful circles, if not always in congressional debates, that industrialization is a highly complex process and that the social dislocations and disorientation which often accompany it may increase, for a time at least, rather than eliminate the kind of social unrest which makes a population susceptible to Communist propaganda.

Cutting across the ideological battles of the cold war has come a growing recognition that the human problems of adjustment to industrial society—inside the factory and out—have many similarities, whether in eighteenth-century England, Russia under communism, or Asia and Africa today. Men and women who have been accustomed to rural life and small-scale agricultural production must leave their ancestral homes and village life for crowded and anonymous urban dwellings. They must also stay within factory walls a specified number of hours each day and work in a manner and at a pace which is decided upon by others. On the economic side, money must be found to build roads and factories; buy, or make, and install machines; and mine, smelt, and fabricate materials out of which machines are to be made. Even with the help given to many undeveloped areas from abroad, the bulk of this investment must come from the savings of the country itself. Consequently, the level of consumption of the masses of the population is inevitably affected for the simple reason, as has been pointed out, that "they are the many," and there is no other source which, over the long run, can provide the substantial sums required.

Despite many similarities, there are also important differences in the ways in which economic development is taking place today in underdeveloped areas. To a far greater extent than ever before, this development is the result of conscious policy decisions on the part of governments—both in the developing countries and in the developed ones who are giving aid. It is especially important to notice that whatever the ideology of governments or individuals, the avowed purpose in most situations—in contrast to the simple profit motive of earlier epochs—is to raise the general standard of living and abolish poverty. Even in the early stages of today's industrialization programs, social protection for the wage earner and his family in the form of health and welfare insurance, unemployment compensation, and other such measures must be provided. Public opinion will not permit these benefits to be postponed until basic industrial capital has been accumulated as was the case in the older industrial countries. But the latecomers have a number of advantages. Not only are they building on an advanced technology developed by others, but they are able to be more sophisticated about the pitfalls that lie ahead. When the cottage spinners and weavers of England were displaced by power machinery, or the wagon and harness makers of the United States by the automobile, individuals were left to adapt as best they could. Today, government and industry in India, to give one example, plan for and worry about the problem of technological unemployment even before the new machines are introduced.

However, in spite of growing awareness of some of the problems and pitfalls inherent in industrial revolutions, the gulf of cultural differences between the developed and the undeveloped countries remains a major barrier to industrialization. A majority of industrialists and governments in the West are still failing to make an all-important distinction—the distinction between *essential* techniques and technologies and their own cultural prejudices. A simple example is in the matter of food. Melville J. Herskovits has pointed out that although the importance of giving native workers accustomed foods has been generally recognized, it is only half the problem.[1] Africans in European industrial concerns have stated that a major difficulty lay in adapting the *time* of eating to their work schedule. They were always hungry and unhappy, not because they did not have enough to eat, but because they were forced to eat breakfast, lunch, and dinner at the times their Western employers were used to eating at home. Their own pattern was for a large meal in mid-morning and mid-afternoon. It is taken for granted in most establishments run by Westerners in undeveloped countries that mealtimes must follow the European or American timetables. But why? If the difference is a much happier work force, is there any practical reason why factory work should not be adjusted to native custom in this respect? This example could be duplicated a hundredfold.

Unfortunately, there is rooted in the history of machine production everywhere the assumption that man must, in general, adapt himself to the machine rather than having the machine—together with accompanying organizational techniques—adapted to him. No one questions, of course, the grave difficulties faced by a people accustomed for centuries to agriculture and handicraft when they turn to modern industrialization. But as some of our selections clearly demonstrate, modern work environments can be—and have been—adapted in many important ways to native cultural patterns.

Perhaps the most deep-rooted of Western assumptions are those concerned with economic motivation. These have been part of the foundations of economic theory—as well as practice—in the West since the days of Adam Smith. The more extreme assumptions about "economic man," as we have noticed in other sections, have now been challenged in Europe and in America. It has been found, for example, that men do not always work best when pitted against each other in extreme individual competition. (See "The Scanlon Plan.") It has been stressed in earlier sections that besides economic incentives other motivations are important. The discovery that we have oversimplified our own economic motives should make it easier to understand that in many countries they hardly exist in a form that the Western trained student or practical administrator would recognize. The following example from the same article by Herskovits makes the point:[2]

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[1] Melville J. Herskovits, "The Problem of Adapting Societies to New Tasks," in B. F. Hoselitz (ed.), *The Progress of Underdeveloped Areas,* University of Chicago Press, Chicago, 1952, p. 99.

> Ironworking has, from very early times, been known throughout Negro Africa. There is good though not conclusive evidence that the technique was developed on that continent. Ironworkers are almost invariably members of a guild, membership in which is customarily based on family relationship, with the craft validated by supernatural sanctions. This is the pattern among the peoples of the Upper Volta River in French West Africa, where knives, hoes, and other implements are manufactured by members of such guilds. Yet because here, as in nonindustrial societies the world over, the lines of specialization are blurred, these men are not the full-time specialists they would be in our society. They are, as a matter of fact, primarily agriculturalists, earning their living only partially by the sale of their products and working their forges principally during that part of the year, the dry season, when the fields are not cultivated.
>
> This is a significant fact, for it is plain that they would have no difficulty in supporting themselves entirely by the manufacture of iron implements. Their numbers in relation to the total group of which they form a part are small. In one series of districts enumerated some twenty-five years ago, there were 60 ironworkers in a population of about 20,000; in another series, there were 39 of these specialists out of some 18,000 inhabitants. It is apparent that this number of ironworkers cannot begin to supply the demand for the implements they produce. This is why, for generations, hoes and bush knives have been imported from other tribes and why more recently, trading firms have stocked implements on the native model made in Europe.
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> One does not have to pursue the matter further to perceive that motivations quite different from those obtaining in the economies of Europe and America are operative here. The question that would occur to one conditioned to the patterns of business enterprise in the Western world would be why these ironworkers do not take advantage of the obvious market at hand. Why do they not supply it by complete, full-time specialization and the training of more apprentices to enlarge their operations so that, as entrepreneurs in the strict sense, they could then hire trained workers to increase further their production? And this is a fair question—fair, that is, for those who approach the problem in terms of current economic theory. All the conditions for the expansion of production are present, yet they are ignored. It is apparent the answer lies outside the scope of economics as envisaged for our culture; that to reach a satisfactory explanation would require probing deep into what we know concerning the psychology of culture, as applicable to this particular situation. And, since, in this case, we have nothing more to go on than the facts that have been provided us and are presented here, we can only have recourse to generalizations about the reasons why a people hold to such customary modes of behavior in the face of patent economic

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[2] Herskovits, *ibid.*, pp. 93–95.

> opportunity—modes of behavior that seem logical, rational, and of self-evident worth to them, while to the outsider they seem so illogical and so irrational.

As many observers have pointed out, in a village economy, agriculture is regarded as the basis of economic life, and handicrafts are viewed as supplementary work to be done in spare time or for special reasons. The native villager never spends the whole day making baskets, nor does his wife devote herself to making pots or weaving from morning to night. Similarly, when industrial work is introduced, he tends to regard it as supplementary to his regular agricultural labors. A man goes to the city and works for a time in a factory to meet a special emergency such as crop failure, illness in the family, or money for a daughter's wedding.

This reluctance to adjust to regular industrial work, all day, every day, year in and year out—the problem of "the committed, disciplined work force"—is recognized as a major problem in every attempt to introduce industry into an agricultural, peasant society. It has received much attention from the practical administrator and the social theorist alike.[3] Many of the factors which enter into it are social, such as the fact that the laborer has often left his family and friends in the village and is drawn back seasonally to cultivate his fields and be reunited with his family. Or he may feel compelled to return for religious festivals and duties. Traditional work habits and resistance to the externally imposed discipline of factory life are also important. And, as has already been indicated, so is the lack of the Western pattern of economic motivation.

The Westerner is baffled when he finds that the Javanese peasant will respond to a rise in the price of coconuts by picking and bringing fewer to market because with higher prices he can meet his needs with less effort. Even when an industrial operation is near his home and the worker is not separated from his family while working, he often leaves when he has earned enough for an immediate need. And an increase in wages, instead of holding the worker to his job, sometimes causes him to leave sooner than he had planned because he can now meet his cash needs with fewer days of work.

Many devices have been tried to meet this problem of an "unstable work force," but the problem remains unsolved in many places. The anthropologist Ralph Linton pointed out some years ago that the difficulty is not that people of other societies are "not mechanical." Citing his own experience, he remarked, "I would back certain Polynesian and Swahili mechanics of my experience against nine-tenths of American garagemen for ingenuity and mechanical know-how." But, as Linton went on to point out, mechanical ability and industrial production are two different things. "If modern machinery is to produce an improvement in economic conditions it has to be operated by labor which will be on the job even though it is a wonderful day and the fish are biting. It is a much easier thing to train an intelligent man to diagnose and repair an injury to a machine than to get him to spend day after day tightening Nut 36 on an assembly line" [4]

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[3] Wilbert E. Moore, *Industrialization and Labor, Social Aspects of Economic Development,* Cornell University Press, Ithaca, N.Y., 1951. Charles A. Myers, *Labor Problems in the Industrialization of India,* Harvard University Press, Cambridge, Mass., 1958.

Obviously there is no quick or easy answer to this problem. It takes time for any group of men to develop into a disciplined work force, and the evidence suggests that a solution lies in a flexible attitude on the part of management coupled with understanding of the customs and cultural prejudices of the peoples involved. In the Guatemalan factory described in one of the following selections, for example, it is the practice to allow time off for civic and religious duties. Charles Myers has noted that many Indian factories follow a practice of allowing workers to return to their villages for religious duties or even to attend to seasonal agricultural work on the land.[5] It is worth reminding ourselves that American industry has adjusted over the last fifty years to the eight-hour day, paid vacations, the two-day weekend, and innumerable holidays. But industry, even in this country, has also learned that, in addition, a certain flexibility is often desirable. In some steel plants in western Pennsylvania absenteeism during the hunting season is expected and quietly condoned. After years of "drives" and efforts to reduce absenteeism during the Christmas shopping season, certain plants of General Motors have recently tried what is termed "planned absenteeism." It has been found sounder and more economical if the workers are encouraged to tell their foreman when they plan to be away so that provisions can be made for replacement and smooth operation without them.

The history of industrial development in Japan is particularly useful in freeing our Western minds from many of their deeply cherished concepts about factory organization. It is often assumed that Japanese industry is a complete imitation of industry in the West and that Japanese social and cultural patterns have also been forced to conform to Western models. The study below, "Social Structure in a Japanese Factory" by James Abegglen, will startle many with the discovery of how wrong this popularly held belief is. Here the problem is not that of an insufficiently committed work force, but the contrary. In Japan, at least in large and important industrial establishments, a worker spends his entire life attached to one enterprise; he neither leaves his employer nor is dismissed except in the most exceptional circumstances. The problems which this practice creates for efficient operation—as we in America have come to understand it—are of hardly less magnitude than the problems of an unstable work force. Yet Japan has created a highly successful industry.

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[4] Ralph Linton, in Hoselitz (ed.), *The Progress of Underdeveloped Countries*, University of Chicago Press, Chicago, 1952, p. 67.

[5] Myers, *Labor Problems in the Industrialization of India*, Harvard University Press, Cambridge, Mass., 1958.

While warning against the conclusion that what is true for Japan is true for Asia as a whole, Abegglen stresses the need of learning from the Japanese experience the all-important lesson that industrial production can be adapted—indeed it must, if it is to be successful—to the social organization of the country and people where it is located.

That the Japanese experience in successful adaptation is not unique is indicated in another of the selections given at the end of this section. The experience of a small 80-year-old textile factory in Guatemala corroborates, in a totally different setting, many of the same points. In *Machine Age Maya,* Manning Nash shows how a primitive Indian community has been able to adapt to factory life while preserving much of its traditional cultural pattern. Again, this study indicates that such adaptation must be a two-way street. It is not only the community that has adapted; the factory has adapted also. This is indicated at many points in the study. The native will not take more machines to tend, says Nash, or run one faster than he comfortably can, despite the incentive of piecework. Commenting on supervision and discipline, the author notes that the foreman or "caporal" gives orders "in terms of Cantel notions about how men are to be treated when they work for each other. . . . [He] does not flaunt his authority nor give many or unnecessary instructions and commands. . . ." The author's remarks on training are suggestive of a continuity of cultural patterns inside and outside the factory. New workers are trained "in a manner similar to learning situations in the home and throughout childhood." A woman learning a new job "neither asked questions nor was given advice." She watched carefully for nearly six weeks and then announced she was ready to run the loom. Adaptation of workers to factory life and the factory to its cultural setting has not been without periods of stress and conflict, and it has been a gradual process extending over many years, but from such cases of successful adjustment those newly embarking on industrial change can learn much.

The important point for America's far-flung involvement in technical and economic aid is to examine with an open mind features of our own "cultural baggage"—i.e., practices which, however essential they seem to us, may rest on a set of assumptions which are the result of our own cultural prejudices but are not necessary to the successful operation of industry elsewhere. Although the effort not to impose our own cultural assumptions on others is essential, it is only part of the problem.

Adaptation to modern industry is affected not only by different social customs, but by differences in fundamental values. We cannot assume that every society wants what we in America appear to want, i.e., a continuous increase in all the products and gadgets which modern industry makes possible. It is often argued that such desires are universal and require only time and the development of a native advertising industry. Even in Europe this has not always proved to be true.

D. P. Mukerji, in "Mahatma Gandhi's Views on Machines and Technology," raises sharply the question of fundamental values. Sometimes quoting Gandhi, sometimes speaking simply as an Indian, Professor Mukerji challenges the assumption that technological advance is a "self-evident good." He also questions the term "underdeveloped countries" as implying that what he sees as two quite different value systems are thereby "placed on the assembly line of historical development in which economic growth, being the supreme value, [is] subservient to and dependent upon technological advance." He asks whether technology should always depend upon wants and their increase to bring about a state of culture in which material wants are king.

However one resolves problems of fundamental value, there is no question that industrial technology provokes resistance in most non-industrial peoples, just as it once aroused resistance in England, Europe, and the United States.

> It is clear that the more rapidly a country progresses, the greater are the aspirations of its people. Industrial development requires educational development; both demand changes in preexisting attitudes, customs, and folkways. Neither are opiates for the people; on the contrary, they are strong stimulants of men's desire for more.
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> At the same time, industrialization creates hardships, grievances, and widespread discontent. It requires a new structuring of the labor force. Factory organization establishes new physical surroundings, new methods and codes of discipline, new working arrangements and social groups. The manager replaces the head of the family or the leader of the tribe as the source of authority. The transition from agricultural work to industrial employment is difficult, and it is all the more painful if it is rapid. Thus, industrial workers everywhere have grievances. In particular, they chafe at the exercise of managerial authority over their day-to-day lives. In some cases they harbor deep resentment and experience extreme frustration. In short, among industrial workers there is always open or latent protest. The feeling of protest is partly negative, stemming from resentment of authority or dissatisfaction with conditions, and partly positive, stemming from aspirations. But irrespective of its causes, it is present among factory workers in all countries whether developed or underdeveloped.[6]

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[6] J. Douglas Brown and Frederick Harbison, *High-talent Manpower for Science and Industry*, Industrial Relations Section, Princeton University, 1957.

Harbison, Dunlop, Myers, Kerr, and Siegel[7] have broken new ground in their analysis of the labor problem in new industrial situations. "The Structuring of the Labor Force in Industrial Society" by Kerr and Siegel[8] is a theoretical contribution of the first importance in its reappraisal of classic theories of the union and labor movements as an outgrowth of and response to capitalism. Making the point that all labor theories of the past have taken as their point of departure capitalism, and usually British nineteenth-century capitalism, the authors hold that these theories can give us little understanding of the labor problem today as it has developed in such countries as Russia, the Argentine, or Israel. It is in industrialism, as such, rather than in capitalism or socialism in any of their numerous variants, that the framework must be sought for a valid present-day analysis and labor theory. In addition to its intrinsic interest as a specific case history, an article on labor problems in an Egyptian textile factory by Harbison and Ibrahim has great pertinence for any discussion of labor-management relations in the underdeveloped nations. The contrast between a high level of technology and management's primitive approach to recruitment, training, and discipline is enlightening. The authors' conclusions are worth the attention of the thoughtful reader, particularly that "labor problems" are in large measure "management problems."[9]

As a practical illustration of this point, the case history of organizational change in an Indian weaving shed by A. K. Rice of the Tavistock Institute is already a classic. Showing, as it does, how organization can be adapted to both the technological requirements and a viable social system within the factory, it has a lesson not only for those now entering upon industrialization, but for industry everywhere. Review of this case, together with its wider implications, is given in the next and final part, How to Think about It: Technology and Human Values.

TECHNOLOGY AND COMMUNISM: A NOTE ON THE SOVIET UNION

Any discussion of technology and industrialization in non-Western countries cannot omit the Soviet Union. Yet its inclusion presents a problem inasmuch as no studies of life in Soviet factories exist comparable to those presented on other countries in this book. With the exception of Professor Emily Clark Brown, who was allowed to conduct actual interviews in Soviet plants in the winter of 1955—although no private talks with workers or local union representatives were permitted—investigators have had to depend on published sources from the Soviet Union or on interviews with refugees.

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[7] Under the Four-university Research Project on the labor problem of economic development.

[8] Clark Kerr and Abraham Siegel, "The Structuring of the Labor Force in Industrial Society: New Dimensions and New Questions," *Industrial and Labor Relations Review*, pp. 151–168, January, 1955.

[9] This point has been expanded in Harbison and Brown, *op. cit.*, and Kerr, Harbison, Dunlop, and Myers, "The Labor Problem in Economic Development: A Framework for Reappraisal," *International Labor Review*, vol. 71, no. 3, pp. 1–15, March, 1955.

With such limited sources, conclusions must also be limited. Students of the purely economic aspects of Soviet industry, despite the difficulties of Soviet statistics and economic reporting, are more fortunate than those who seek to know something of the varied and intangible problems of human adaptation to industrial technology. Nevertheless, it is perhaps safe to say that the Russian experience is enlightening, first, precisely because of its failure to recognize the need to adapt technology to cultural and human factors; second, because there are indications, noted by the late Jerezy Gliksman, that technology itself is now forcing a change in Soviet labor policy in the direction of greater attention to the morale of the individual worker as a factor in productivity.

Marx and Engels were keen observers of the social ills and human hardships that accompanied the introduction of modern technological change in nineteenth-century England. But they did not, generally speaking, attribute the misery and difficulties to the industrialization process itself. For them, no less than for the classical economists and early capitalists, industrialization was economic "progress" and inherently good. The evils they so passionately recorded were, they believed, due to capitalism and its "exploitation of the working class." Although they did not visualize the introduction of socialism or communism until after the transition to an industrial society, there was little in their writings or doctrines to suggest to their twentieth-century followers that there were human problems, apart from those caused by the capitalist system, inherent in the actual process of industrialization.

Convinced of their own mission as the chosen instruments of history, and with a faith in the virtues of technology and industrialization which few capitalists could equal, the Russian Marxists have felt no qualms in sacrificing a generation on the altar of "catching up with the West." All the ensuing difficulties have been attributed to the backwardness of Russia, including its working class, and the isolation of the U.S.S.R. in a hostile capitalist world.

The conclusions which the West drew from the grim picture of working conditions in postrevolutionary Russia have, unfortunately, been as undiscriminating as those Marx and Engels drew from England in the 1850s. We have tended to blame all the problems and hardships on communism as such, ignoring the fact, which by now should be obvious, that the human problems—both physical and cultural—of large-scale technological change are bound to be great. This is not to condone the ruthlessness of Soviet leaders or the political repressions which prevented the workers from defending themselves as workers in the freer political systems of the West eventually did. But the lesson of the last forty years of industrial change in Russia is important for an age of technology, and put as simply as possible, it is that the problems of the transition period cannot be solved in terms of "ideologies," whether those of "capitalism" and "free enterprise" or of "socialism." Rather, they must be dealt with in the concrete terms of economic, technological, and cultural realities.

No student of Russian labor has written more carefully or perspicaciously than Jerezy Gliksman. The selection below, written a year before his untimely death in 1958, is of special interest because it confirms what other students of Russian industry such as Professor Brown and Solomon Schwartz have suggested, that the logic of advanced technology itself forces upon those responsible for industrial management, regardless of ideology, the necessity of winning the voluntary cooperation of workers. It is true, of course, that the Russians have never depended solely on coercion to win worker cooperation. Yet since Stalin's death, and increasingly in the last few years, there appears to have been not only a modification of coercive measures, but an increased effort to create higher morale and a greater degree of interest and voluntary cooperation. If Dr. Gliksman's interpretation of these changes is correct, the basic force behind them is the pressure of an ever more advanced and complex technology. As we have seen throughout this book, the higher the technological level, the greater the need for an intelligently cooperative work force.

Elsewhere, Dr. Gliksman has quoted a saying of the historian Arnold J. Toynbee which might sum up the point to be made: ". . . You cannot get this kind of [skilled] work out of human beings by brutal methods that are effective . . . for making a galley slave row or a plantation slave hoe. Skilled work cannot be exacted by force. . . ." (Quoted by Gliksman in "Recent Trends in Soviet Labor Policy," RAND Corporation, Research Memorandum RM-1756.)

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1. SOCIAL STRUCTURE IN A JAPANESE FACTORY

Adapted from James Abegglen, *The Japanese Factory*, Massachusetts Institute of Technology, Cambridge, Mass., 1959.

Japan's extraordinary history of industrialization remains a unique record of effective social change, compelling the attention of those concerned with problems of industrialization and economic development in non-Western societies. Japan strode from hard-held Asian insularity to a central role in world industry, world trade and world power-relations in a single, explosive burst of energy. The outlines of the story are familiar; its implications for present attempts effectively to bring about industrial development in other countries are evident.

Analyses of the process of industrialization and the causes of economic development in Japan proceed, generally, on the assumption that the outcome of industrialization in that country has been, in terms of social organization and interpersonal relations, largely identical with the outcome of industrialization in the West. This assumption not only underlies much of the academic analysis of the nature of the Japanese experience in the transition to an industrial economy, but also is implicit in much of the effort to increase productivity in the Japanese factory. Owing in part to this assumption, methods and machines useful in British and American production are introduced into the Japanese factory with little attention to their appropriateness in what may be a markedly different organizational context. The assumption of identity in organizational systems and in relationships in industry is in error. As a consequence, some of the analyses of the causes of Japan's industrialization as well as much of the effort to increase Japanese production do not achieve their purpose.

In the critical areas of interpersonal relations and group interaction, in the definition of the nature of the industrial relationship between worker and company, and in the way in which skills and energies are mobilized and directed in the group, the Japanese factory is a variant of industrialization quite different from the American factory. These variations may be seen as essentially deriving from the differences between the broader social systems of the United States and Japan. An understanding of these variations is essential to an understanding of Japanese industry, and, more important, to working with and effectively assisting in its further development. From the Japanese experience, too, relevant clues may be gained as to the kinds of problems that will be encountered with the introduction of industrial technology into other non-Western nations.

The Critical Difference: A Lifetime Commitment

When comparing the social organization of the large factory in Japan and the United States one difference is immediately noted and continues to dominate and represent much of the total difference between the two systems. At whatever level of the organization in the Japanese factory, the worker commits himself on entrance to the company for the remainder of his working career. The company will not discharge him even temporarily except in the most extreme circumstances. He will not quit the company for industrial employment elsewhere. He is a member of the company in a sense resembling that in which persons are members of families, fraternal organizations, and other intimate and personal groups in the United States.

This rule of lifetime commitment is truly proved by its rare exceptions, and this permanent relationship between employee and firm imposes obligations and responsibilities on both the factory and the worker of a different order than that on which personnel practices and worker-company relationships in America are built. The labor exit rates of a large firm for the past several years will illustrate Japanese practice. The plant in question was an electrical equipment manufacturing firm in the Osaka area. Of an average employment of roughly 4,300 persons, five or six were discharged each year, or about one out of one thousand. These discharges were for reasons of extreme behavior—e.g., a man who had not been in the plant for some weeks, following on a series of similar absentee periods, or a worker accused of habitual and substantial thievery of company property—that is, the breach of conduct was so considerable in these cases as to allow no alternative to discharge.

As to labor exits other than discharge, the annual rate for the five year period 1949–53 was 83 out of 3,337 men and 109 of a total of 1,014 women, or a labor departure rate of between 2 and 3 per cent for the men and about 10 per cent for women. Of the men, about two-fifths had reached retirement age; the remainder leaving for reasons of health, or, more often, to return to the family farm on the death of a father or brother. (Since 1953 the exit rate for male employees in this firm has actually dropped and in 1956 was at the rate of 1.7 per cent annually.) Marriage accounted for almost all of the exits among the women who rarely remain in company employ until the retirement age of 50. In all companies both company pressure and social custom almost demand that a married woman leave the job market. This firm is in no way exceptional in the rate of exits among its employees. The figures include both management personnel as well as workers.

It must be noted particularly that temporary lay-offs because of lack of work do not take place in this firm or any other firm encountered in the course of this study. The company has full responsibility for the continued salary of all its employees for the duration of their employment, which is usually the full term of the working career. It is no wonder that these are called "permanent" or "eternal" employees.

Viewing the over-all social organization of the Japanese factory, it is clear that this lasting commitment of the employee and the employer is the result and a striking example of a major difference between Western and Japanese job relationships. The Western relationship is more nearly "contractual." Both parties to the contract in Western nations note that under certain conditions, not necessarily related to the worker's performance of his job, he will be free to leave or the company will be free to dismiss him. He may be offered a higher position in another company, more pay or leisure, better opportunity or a more advantageous location. No particular stigma attaches to his leaving. On the contrary he may well be regarded as a more intelligent, more ambitious, more able person for having found a better position. In the same manner, the company, while more limited in its discretion, may for reasons usually having to do with its financial position terminate the relationship.

In the Japanese factory loyalty to the group, and an interchange of responsibilities—a system of shared obligation—take the place of a purely economic basis of employment. The area of mutual interchange of responsibility and obligation goes considerably beyond the regulations and practices governing employment and dismissal.

Labor Surplus and Technological Change

In the Japanese factory at the present time it is commonly noted and readily admitted that there is almost always a surplus of personnel, both managerial and shop, over the number required to maintain the level of production. By American factory standards there is an astonishing proliferation of make-work jobs, jobs often of a menial sort—tea servers, sweepers, messengers, doorkeepers and the like—which could be substantially and easily reduced in numbers, as well as a great deal of inefficient use of time and energy in productive jobs.

One consequence of this labor surplus is that labor costs are such that a machine becomes a luxury. This has an effect upon technological change. Clearly where a surplus of labor presently exists there is a much reduced incentive to introduce new methods or machinery. The result is to enhance a conservative attitude towards change which is already fairly strong in the thinking of factory management. Several factors, however, make for an inexorable shift toward increasingly mechanized, labor-saving production methods and an exacerbation of the problem of labor surplus. One of these is, of course, the output of new products either through the purchase of foreign patents, or, less often, through local development. Ordinarily less labor is required for the new product than for the one it replaces.

Another factor in forcing technological change is competition with and imitation of foreign industry. Japanese management looks now, as in the early development of Japanese industry, to foreign and, at present, chiefly American, sources for ideas and techniques. The introduction of new methods and machines exacerbates the problem of a labor surplus and so retards the introduction of new technology in Japanese plants. It should be noted that in the United States technological unemployment might become a community or national problem of a total surplus of labor; in Japan it would present a serious problem for the particular management of the factory which introduced the change.

Recruitment, Promotion, and Reward

Recruitment of personnel, promotion policies, and systems of reward likewise are based upon quite different assumptions than is the case in the American factory. Recruitment into the productive group is based on personal qualities without reference to a particular work task or set of skills. Selection is based primarily on the individual's education, character and general background. Inadequacy or incompetence shown subsequent to employment are not a basis for dismissal from the group.

Status in the group is a continuation and extension of status held in the society at the time of entrance to the group. Broadly the factory is divided into two distinct groups. The first, the *koin*, comprises apprentices, workers, group leaders and foremen. They are graduates of the old system of higher primary schools or the present day middle schools (equivalent of our junior high schools). The *shokuin* group are graduates of high schools and colleges. Clerical and lower level positions are held by the high school graduates while only college graduates may occupy the higher positions or be eligible for top management. Promotion is limited within the factory system by the general category that the individual's education entitled him to enter on recruitment.

Reward of personnel at all levels is only partly in the form of money, and is based on broad social criteria rather than production criteria. The recompense of workers is made up of such items as housing, food, and personal services, with the actual cash pay forming only a part of the total. Pay is based primarily on age, education, length of service, and family size, with job rank or competence only a small part of the criteria for determining work reward.

The penetration of the company into the nonbusiness activities of the worker and his family is extensive. Management is involved in such diverse and intimate matters as the worker's personal finances, the education of his children, religious activities, and the training of the worker's wife. The company is responsible for the continued well being of the worker and his family, and this responsibility is carried out both in formal personnel procedures and in the informal relations between worker and supervisor.

The formal organization of the factory is elaborated in a wide range and considerable number of formal positions. Formal rank and title in the hierarchy are well-defined, but authority and responsibility of ranks are not. Partly in consequence, the decision-making function is exercised by groups of persons, and responsibility for the decision is not assigned clearly to individuals.

Productivity in the Japanese Factory

In terms of modern production methods as understood in the West, the whole mechanism of job evaluation, cost analysis, and the incentive systems can find no place in the large Japanese factory without clashing with the present system. It is perhaps not too much to say that in the American firm the underlying assumption of incentive methods is one of individual responsibility to which the informal group makes certain adaptations. In the Japanese factory, however, it is group work and group output that measure success, with only some minor accommodations to individual differences.

It is on this general point that many of the efforts to introduce new, usually American style, methods into the Japanese firm flounder. Japanese engineers and managers attempting to introduce quality control and cost analysis into the Japanese plant find themselves unable to obtain the necessary information and support; American technicians fail to communicate successfully what it is they are trying to accomplish. In both situations the difficulty appears to stem from the fact that the Western methods rely on assumptions about the nature of the work experience that are not valid for the Japanese work situation.

The problem of a permanent labor force complicates direct comparison of productivity in American and Japanese factories. Fixed costs in Japan are not confined to such items as inventory and equipment. Labor, too, in Japan represents a fixed cost, one not susceptible to adjustment as conditions require. The problem for management is not one of reducing the amount of labor required in production but rather to maximize it in order to actively employ the entire work force and reduce proportionately the investment in equipment, power and space. Because of the great difference in the social organization, Western-inspired technological changes can have only a limited effect on the productivity level and, indeed, in some respects tend to aggravate the problem. For example, labor-saving machinery can hardly be seen as beneficial to management when the displacement of labor costs by machines compels management to add that labor cost to some other part of the total operation. Systems of management and production which reduce the labor requirement can become actually harmful in the Japanese factory.

Taken together, the system of recruitment; of promotion strictly governed by educational background, age, and seniority; and of a reward system based on considerations which for the most part are irrelevant to productivity mean that the methods for increasing productivity commonly applied in the West are extremely difficult to apply in Japan. Change in one area of the total factory complex will involve change in a whole series of areas and the total effect is not always positive. Given what are to the eyes of the American engineer or technician glaring and obvious inadequacies in the Japanese production methods, suggestions and recommendations for changes are freely offered the Japanese. Further, seeing the success of American methods in the American setting, there is no small readiness on the part of many Japanese to study and attempt to institute American production methods. Some of the ways in which the abrupt and piecemeal imposition of American technology in Japan meets with unfortunate results are evident from this study. Taking only the introduction of new machinery designed to reduce the labor load in production, a whole series of problems are raised by this kind of change.

The problem is not confined to cases involving American methods and technicians. Younger Japanese technicians, whose background and training makes them unfamiliar or unsympathetic with older folkways, sometimes find themselves in trouble because of insufficient consideration of traditional cultural patterns.

In a number of plants where the component of technical training was of particular importance an intermediate post was introduced between foremen and branch chief or manager. It was ordinarily filled by young college graduates who, as a result of the recruitment and personnel methods used, could not be placed in first line supervisory posts. As recent graduates from college, they were not sufficiently experienced or trained to assume management responsibility. At the same time, owing to their status when hired, they could not be placed as workers. They were therefore assigned variously titled posts in which they acted as technical assistants to general foremen.

The creation of these intermediate positions is a good example of the kinds of adjustments and accommodations forced on the Japanese organization by the nature of the worker-firm relationship, and the conflicting demands of technology and interpersonal relations. An extreme example of this conflict is provided by the situation in a mine in Shikoku, which is part of a major complex of metal production. The miners are recruited from the mountain villages near this isolated section of Shikoku Island. In many cases several generations of the same families have worked in the mine. The role of tradition, superstition and local custom in the actual mining operations is very great, and the men can be effectively supervised only by foremen and leaders thoroughly familiar with these customs and traditions. The young college graduates who will manage the mine, however, are recruited from the universities of Tokyo by the main office and dispatched to the mine area for a period. Although technically competent, these men are totally unequipped for supervision in these special circumstances. For example, if a miner should break a dish at breakfast he will under no circumstances go into the mine that day, believing that to do so would be certain death. Locally trained supervisors understand and respect this belief; young graduates of Tokyo's giant universities are less likely to be sympathetic. To make personnel procedures fit the realities of supervisory demands in the mine, the company has developed a system of having two persons fill each of the intermediate supervisory posts. One is an experienced man with years in the locality. The other is a young engineer who may or may not remain at the local work situation for his full career. He must at any rate leave the actual supervision of the miners to his partner.

There are many similar situations in Japan; this is merely an extreme example of a common problem. What is perhaps most important to note in this situation is the fact that the requirements of efficiency and rationalization of the productive organization yield to the demands of the social context in which the factory operates.

Continuity and Change in Japanese Industry

If a single conclusion were to be drawn from this study it would be that the development of industrial Japan has taken place with much less change from the kinds of social organization and social relations of preindustrial or nonindustrial Japan than would be expected from the Western model of the growth of an industrial society. The rise and development of the industrial West is generally attributed in some considerable part to the development of an impersonalized and rationalized view of the world and of relations with others. Emphasis on individuality, the view of the workplace as a purely economic grouping clearly differentiated in goals and relationships from other areas of social interaction, the subordination of other values and interests to the economic goal in business activity, the use of money to discharge obligations for services in the business world—all these and related trends are seen as critical to the successful development of large-scale industry.

It may well be that the kinds of experiences undergone by the West antecedent to the development of modern industry are indeed essential to an independent and *de novo* industrial development. The Japanese case suggests that these experiences and the organizational system used in the West are not necessary to the introduction of industry into another social system. From the observations of this study it would appear that, although the technology of modern industry was introduced into Japan, the organization of the factory developed in a manner consistent with the historical customs and attitudes of the Japanese and with the social system that existed prior to the introduction of modern industry. Thus, looking beyond the modern equipment and the formal organization, the systems of relationships are more nearly similar to those which seem to have characterized an earlier Japan and which now characterize the nonindustrial areas of Japan than they are similar to the factory organization of the West. It does not seem warranted to hold that Japan is now at some midpoint of development nor is it sufficient to say that since Japan's industrialization is relatively recent these divergencies from the pattern as seen and set forth in the West will in time mend themselves. In point of fact, as this report has attempted to indicate, the Japanese system is on the whole self-consistent.

Differences in the role of the individual in the Western and Japanese factory—the ways in which he is motivated, the extent to which responsibility and authority are assigned to individuals, the kind of reward offered, and the behavior rewarded—have a close relationship to differences in the two cultural backgrounds. Japan's industry was superimposed in a matter of some few decades on a society that was profoundly and had for some centuries been feudal. The loyalty of the worker to the industrial organization, the paternal methods of motivating and rewarding the worker, the close involvement of the company in all manner of what seem to Western eyes to be personal and private affairs of the worker—all have parallels with Japan's preindustrial social organization.

This parallel does not underestimate the enormous changes that have taken place in Japan through the period of her industrialization. Japan has changed mightily; and changes continue. If the study of industrialization in Japan is to be relevant to the study of the developing economies in other Asian nations, however, the nature of these changes must be clearly understood. What the results of this study of the social organization of the large Japanese factory suggest is that changes have taken place selectively—and, more important, that these changes have been such as to leave unchanged the underlying basis of social relationships. Rather than penetrating to the roots of the social system, the changes have been built up from the kind of social relationships pre-existing in Japan.

It would seem from this study, then, that the very success of the Japanese experience with industrialization may well have been a function of the fact that, far from undergoing a total revolution in social structure or social relationships, the hard core of Japan's system of social relationships remained intact, allowing an orderly transition to industrialization continuous with her earlier social forms. It would in fact be remarkable if social change of this magnitude and success could occur in any other way. Discontinuity will not lead to effective adaptation; rather, it will result in chaos. The exceptional durability of Japan's social system, often remarked and demonstrated anew in her response to total defeat in the Second World War, is not the result of a mystic ability of the Japanese to adapt but, rather, the consequence of the fact that through change a basis for social continuity has remained intact. It is of some interest to note in this connection that the same wondrous ability to selectively take on new elements is now being attributed to Indian society. But selective adaptation should not be remarkable; it would be much more remarkable if any people were able in one fell swoop to put off their past, their training and habits of mind and don successfully and permanently totally new social paraphernalia. Efforts to change the economy of other nations in the direction of industrialization might better then be concerned with an identification of basic elements of the preindustrial social system and with the introduction of new technologies and financial systems in the context of older relationships, than with making these nations over in the image derived from Western culture. It may be true that the Western style of organization maximizes productivity, but substantial industrial progress can be made within a quite different style of organization. Rationalization and impersonalization are not, the Japanese experience seems to argue, necessary to the adoption of an industrial economy.

The Japanese experience appears relevant to present concern in the United States with the problem of aiding the development of other non-Western nations. It would seem from the Japanese example that a considerable degree of tolerance—even at the cost of seeming waste—needs to be allowed local customs and methods in establishing industry in those countries with systems of interpersonal relations markedly different from those of the West. A lasting and effective transition to industrialization may be accomplished only when the changes are continuous with the preindustrial social system and are based on and grow out of the patterns of social interaction basic to the society.

2. MACHINE AGE MAYA

From Manning Nash, *Machine Age Maya: The Industrialization of a Guatemalan Community*, American Anthropological Association, Memoirs no. 87, Menasha, Wis., 1958.

INDUSTRIALIZATION: AN INQUIRY INTO IMPACTS

This is the story of the people of Cantel, an Indian community in the western highlands of Guatemala. It is the description and analysis of a people who have successfully moved from a simple farming technology not much removed from that of their pre-Columbian ancestors, to operating in their midst Central America's largest textile mill.

The adaptation of this Indian community to factory work, cash wages, and to wider ties with the modern industrial world is a precipitate of history. Accommodations between the Indian culture and the factory came through the process of trial and error over more than three generations, without blueprint, without planning agency, and nearly without notice. Today, in the highlands of Guatemala, a people still speaking Quiché, the women yet in costume, the world view of spirits and saints largely intact, have learned how to coexist with a factory regime. Cantel, of course, has changed since the coming of the factory. But the changes, as will be noted later, have been of the kind which permit the people to keep their social integrity and their cultural distinctiveness.

The study of Cantel serves two chief purposes. First, it tells of the way this particular community evolved mechanisms enabling it to adjust to a new mode of production with relatively little cultural loss or social disorganization. Second, Cantel's experience sheds light on the process of industrialization itself, sharpening our insight into social and cultural change, and clarifying our interpretation of cause and effect. . . . These twin theoretical or scientific goals conduce to the practical end at which all science, social included, eventually aims: the conscious and knowledgeable intervention of man in his own affairs.

THE PLACE AND THE PEOPLE

Cantel is one of a series of Indian municipios in the western highlands of Guatemala. Like many other Indian communities, it is a distinctive social entity. Its physical boundaries are clearly marked. Its inhabitants wear a distinctive costume, and they speak a local variety of Quiché. The customs of its population vary in small but infinite ways from neighboring municipios. Cantel's radical difference from other municipios is the presence within its boundaries of Central America's largest cotton textile mill and the employment in that plant of about a fourth of its economically active population.

THE FACTORY: ITS INTRODUCTION, HISTORY, AND RELATION TO THE COMMUNITY

In 1876 the Spanish firm of Sanchez y Hijos brought a cotton textile mill into the municipio of Cantel. The mill was set up along the banks of the Samalá River, because its flow gave enough power to run a turbine, which in turn powered the spinning machines and other machines in the factory. The Cantelenses resented the factory. Stories of the fears then current are recited today with a note of mockery. In 1884 this resentment turned to an attempt to oust the factory. In response to this threat, soldiers of the national army were stationed around the factory and in the town center of Cantel. The presence of troops curbed overt antagonism but the first workers in the factory were not from Cantel, and Cantelenses did not come to the factory in any numbers until about 1890.

Prior to 1880 the factory employed about 25 persons. Since the turn of the century the work force has fluctuated between 800 and 1,000 persons. Although my data are not full for the period prior to 1945, it is clear that absenteeism, worker discontent, and a fairly extensive turnover were chronic features of the factory until the third or fourth decade of this century. The factory management gradually began to add services and make concessions to the workers which reduced the attrition in the labor force and apparently helped stabilize it. The factory began building houses in 1910, increasing the numbers available to workers until 1945. The main streets of the factory settlement, the public buildings, and many of the factory-owned workers' houses were equipped with electricity in the early

1930's. A clinic was established, and twenty years ago a factory school was opened. Land was loaned to workers without charge. Random interviews with many workers indicate that long, continuous periods of employment are now the rule.

This earlier state of coercion, of bringing in foreigners, of recruiting marginal Cantelenses to work, of low wages and long hours, might be considered a deterrent to the present accommodation of the factory and the community and to the commitment of a Cantel labor force. But just the opposite has in fact obtained. What could easily have been a heritage of suspicion and fear has been converted by the Cantelenses, through comparison with the currently better and freer circumstances, into a base line from which to judge present advantage. The first responses of a people to cultural intrusion do not necessarily have the same positive or negative aspect after a time-seasoned judgement.

Relation to the Community

In the period since 1906, but chiefly since the 1930's, the factory and community have gradually worked out an accommodation. Through mutual concessions, the basis has been laid for a smooth integration of the factory into the community, and of community personnel into the factory. The modifications which permit the factory to go about its business of production and the community to continue its institutions were discovered in the process of living side by side, rather than planned.

Factory work schedules take into account the traditional holidays of the community, as well as the traditional obligations of community members. Periods of fiesta, like the town fair and Easter Week, are not factory work periods. These long holidays are covered by Saturday afternoon overtime, not a usual period of factory operation. Neither production nor wages are reduced as a consequence of holidays. The four-hour period between shifts allows the factory worker with a small plot of land to attend to his agricultural duties without taking time off. It also permits women to do some of their household chores or to nurse small infants. If a man's turn comes up in one of the civil or religious offices the factory gives him time off, ranging from an afternoon to a two-year leave, without his suffering loss of job or tenure.

When it is asked why Cantelenses came to the factory, the first answer is poverty. A real difference in income between factory and farm workers, coupled with the gap between ideal standard and the actual level of living, may be considered the propellant for seeking factory employment. Many of the factory workers were women and young men who, outside of the factory, would earn no income. For these classes of workers the factory represents a complete economic advantage, not merely a relative one in terms of alternate income possibilities.

The factory wage has certain other characteristics which make it appealing when contrasted with farming income. It has regularity and continuity. Agricultural return, both for hired hands and proprietors, has peaks and troughs corresponding to the harvesting, planting, and marketing cycle.

The regularity and continuity of factory income are valued because Cantelenses like to be able to say that they are free of debt, independent and able to buy what they need when they need it. In addition to the pull of wages, the factory offers social services. Housing is provided in 125 rent-free houses. The social importance of having or owning a house cannot be overestimated in Cantel.

The factory also maintains its own school, clinic, and doctor. The school has a six-hour day in contrast to the four-hour day of the national school; this longer school day is considered advantageous for the absorption of knowledge. Medical facilities provided by the factory include a clinic where simple remedies are dispensed and medical advice and prescriptions are given.

To some 30 to 40 per cent of its workers, the factory loans up to two cuerdas of land. This loan of factory land may yield an increment to cash income as well as giving some of the landless a sense of ownership of soil, a strong value in this peasant community.

Factory work allows a man to become eligible for the Guatemalan system of social security, a kind of accident and health insurance rather than an old-age or retirement plan. There is no health service for the non-factory workers in Cantel.

Such are the economic dimensions of the factory's attractiveness: a clear and significant income differential, social and medical services, and the possibility of house or land provided by the factory. They have pull in a context of rural poverty and inadequate land resources.

Adapting to a New Occupational Role

Between recruitment, which is accomplished by the factors enumerated, and commitment, which is personal involvement in the industrial work cycle, lies adjustment or adaptation to a new occupational role. The Canteleno in the factory finds himself working under conditions for which there are no homologies in his society or life experience. He often comes to the factory illiterate (for the past four or five years only "literates" have been hired), without previous experience with machinery of any kind—neither the gadgets of the housewife nor the motors and tools of Western men. The incoming worker is accustomed to small groups where work is carried out by men doing a variety of things rather than by division of labor which requires coordination and teamwork in adjusting to a machine tempo. He is accustomed to work without direction or supervision. He works with relatives or acquaintances, not strangers, choosing with whom he shall share effort. If he is tired or ill he need not go to his field, but the factory has a fixed hour for reporting and a fixed period of continual effort. In agricultural work, performances are judged by the farmer himself against a physical harvest; in the factory, output is measured by impersonal standards of so many inches of cloth, and there is no product which is the worker's own. This discontinuity between the occupational roles of farm and factory worker sets the problem of the individual's accommodation to factory work.

The factory work is now accepted as part of the natural landscape; the railroad that once whizzed by the Pueblo, the bulldozers that came to make the new national highway that is to pass below Cantel, the newly installed water system, and other such changes have their momentary upset in communal life and then are quickly taken as the "natural" part of the environment over which Cantelenses have no control. This can be put another way; as personalities, the run of Cantelenses have a streak of resignation to fate, be it of the natural world or of the larger social world, and when they see that a thing is inevitable they work out some kind of adjustment to it.

One final kind of personal trait strikes one about the Cantelenses. They are personally well disciplined and regular in habit. The clock is perfectly suited to the way they like to run their lives. An orderly, undeviating daily routine, seasonally adjusted, is an ideal nearly approached by Cantelenses. And this accords with the general lack of flamboyance or "style" in almost any aspect of personal life. There are no specialized skills in love-making, in cooking, in drawing embroidery designs, in songs, or in dances. Personal creative ability means a break with traditions, and the Cantelenses would be suspicious of it and perhaps would not even understand it. They have no desires or psychic energies to give to the creation of experience or beauty which passes ordinary and common occurrence.

Learning New Work Habits

New workers in the factory are trained by other Cantelenses, in a manner similar to learning situations in the home and throughout childhood. A man or woman is hired as an assistant on some machine, say a weaving or spinning machine. For five or six weeks the newly hired worker performs menial tasks such as bringing material to the machine or taking finished goods off of it, but most of the time is spent in observing the operations of the person running the machine. I have spent hours watching a new employee learning a job. In one case a girl was learning to tend a loom. She would take her place at the side of the loom operator in the morning, bringing the cones of dyed cotton. Standing by the machine she watched the operator go through the motions of running the loom. She neither asked questions nor was given advice. When the machine snagged or stopped, she would look carefully to see what the operator did to get it back into motion. When a table cloth was woven, she removed it from the loom. This constituted her daily routine for nearly six weeks, and at the end of this time she announced that she was ready to run a loom. Her foreman told me that at no time during her learning and apprentice period had she touched a machine or practiced operating. When she said she was ready, the machine she had been observing for six weeks was turned over to her and she operated it, not quite as rapidly as the girl who had just left it, but with skill and assurance. What went on in the "training" period? The apprentice was applying the way of learning she has been taught in Cantel. She observes and internally rehearses the set of operations until she feels able to perform. She will not try her hand until she feels confident, for to fumble and make mistakes is a cause for *vergüenza*—public shame. She does not ask questions because that would annoy the person teaching her, and they might also think she is stupid. After sufficient observation the apprentice arrives at the point where she feels that she can carry on the necessary physical operations. I have observed this method of learning among the home weavers with their young apprentices, among the young boys who learn to drive cars, and even in the case of a man who was learning to sing but never sang a note until after a five or six hour session of just listening. In this way the recruit is inducted into his new job and its new skills easily and according to customary training patterns.

This method of learning no doubt has severe limitations and may not function when the learning is symbolic or of purely mental operations, but it works in teaching the simple tasks of running cotton textile machines. Management reports six weeks as about the upper limit of anyone learning to run a loom or a spinning machine. I am told that operating the more complex jacquard requires more learning time, and the factory looks for the *listos*, the bright ones, among its working forces to train as operators. But for the other operations the illiterate farmer or housewife, a stranger to machinery, is converted into a reasonably proficient factory hand in six weeks.

The learning process is slightly modified when a Canteleno learns to be a caporal, machine shop worker, or assistant in the electrical shop. Here the technical staff gives verbal instruction and explains the principles and operations of the machine or instrument. The technical staff complains that Cantelenses do not practice and often make serious and costly mistakes when they think they can operate one of the more complex machines. In the more skilled jobs, the complaint is that Cantelenses are often "indifferent and unenthusiastic" when they learn. This complaint of the foreign technical staff is a recognition of the Cantelenses' desire to appear calm and dignified, even when a neophyte may be eager to learn new skills.

These qualities of reserve, patience, and caution often make the Cantelenses seem, to Western eyes, slow-witted or dullards. But this is not so; they learn quickly if the conditions are right as in the factory, and many are keen observers of their fellow men. It is only the necessity of exercising personal controls to appear reserved, calm, and prudent in public behavior which gives the social life of Cantel its characteristic tone of an unruffled, even tenor, of a placid, emotion-free existence.

Factory training, where results are rapidly achieved, contrasts with the training situation in the school. Teachers say it is difficult to get performance, and Cantelenses say that too much school work or thinking makes the head *caliente*, hot, and leads to minor illness.

Tempo and Routine of Work

The tempo of the machines requires constant attention and care, but such application does not appear to be a major factor in the adjustment to industrial work. The Canteleno will not take more machines to tend nor run one faster than he comfortably can, despite the incentive of piece work. Compared to North American mill hands, the factory managers report that the Cantel worker is slower and runs fewer machines. Whether this is due to the worker or to the age of the machine and its disposition in relation to the task, I do not know. But the pace of the machines does not appear man-killing, and the Cantelenses say it is not. The unaccustomed posture of standing all day or using the same set of muscles all day is not considered much of a strain. The minor changes in body work rhythm and in constant application required by the machine are taken to easily by the Cantelenses, and I could not elicit one complaint about factory work on that score. From watching Cantelenses run machines, it appears that changes in motor habits and working strains do not require much psychological reorientation or occasion physiological crises. For the majority the shift in work pattern is not a jolt, but at most only a little ripple which in a year or so is not even easily recalled, and questioning about the problem usually brings blank stares or long pauses while memory is ransacked for "difficulties" in adapting body tempo to machine tempo. Those who did not adjust to the tempo have left the factory, and of the ones with whom I have talked, none who are now engaged in economic activity left because of the difficulty or strangeness of the work. Only one man, whose bare feet on the wet concrete floor of the dyeing room bothered him, complained to me that he found factory work more unpleasant than farm work.

Supervision and Discipline

Working in coordination or under orders does not appear to make factory work less desirable. Work at the machines is coordinated by a caporal in charge of a line of machines. He is a Canteleno. He and the worker he directs understand each other. The caporal never raises his voice when giving directions, and rarely tells a man what to do. Only occasionally does he call out *"apúrate,"* or hurry up, when someone slows down at his machine. If the worker is on piece work, he is more likely to call out to the caporal to adjust the machine if it is stalled or slowed. The caporal's authority is limited by his sense of how it should be exercised; that is, he does not order but rather suggests what is to be done. Workers seldom complain that they have been mistreated or that a caporal is unreasonable in his demands.

Before the organization of the union, the supervision and discipline routine was less to the taste and custom of Cantel. The foreign engineer, not bound by conventional understandings as to the proper exercise of authority, was wont to circulate about the room and slap laggards across the head. The factory owners on their periodic visits did the same. Physical force and abusive language were used by the factory owner and the technical staff to get things done in the way they wanted them done. The workers always objected to this treatment, since being publicly reprimanded is scandalous and shameful, and being struck as a means of correction puts one in the category of a child. I cannot judge how great a factor this discipline was in labor turnover prior to the union; it was not given as a reason in any of the cases of which I have record. However, the union frowned on physical punishment of any sort. The British engineer struck a worker who had ruined an expensive machine, and the union brought a complaint against him; he was asked to make a public apology to the worker in the presence of the manager. This affirmed the principle, operative since the late 1940's, that discipline was the job of the caporal. Caporals could use any means except insult and corporal punishment.

There is little status difference and no sentimental differential between the caporal and the worker in his line. Both are workers, distinct from the clerical staff and the managerial interests. In exercising his authority, which stems from the imperatives of keeping the machines operating and coordinating work so that the flow of materials does not occasion lags between operations, the caporal takes his orders from the technical staff and passes them on to the line worker according to the impersonal needs of the job. But the way in which he gives orders is in terms of Cantel notions about how men are to be treated when they work for each other. The caporal is a worker who gets slightly more pay; he is not of, and not necessarily for, the management. Outside the factory walls the foreman's prestige is no greater than that of the mill hand. Inside the mill, the caporal does not flaunt his authority nor give many or unnecessary instructions and commands, and neither his dress nor his language marks him off from the machine hand.

Strict observance of the cultural definitions of authority and its legitimate exercise by the caporal gives supervision and discipline the same tone as the organization of simpler work groups in the agricultural tasks. The virtual status coincidence of caporal and line worker insulates the management from the workers, and keeps the owners in the dark as to why one set of machines turns out only so much when they think it should be producing more. The pace on a line of machines is set by the more experienced workers, and the others, including the caporal, take it as the given pace.

If the relationship between caporal and worker serves to isolate management from worker, it paradoxically encourages the paternalistic relationship between worker and employer, so common in Latin enterprises. Since the caporal is not an intermediary, the worker expresses his grievances directly to the patron—the owner or white-collar employee. Prior to unionization, and even afterward, the smallest grievances were carried directly to the patron. In our conception of him as policy maker or entrepreneur he would never concern himself with settlement of such picayune affairs, but he personally collected information and handled the problem in a face-to-face way. This mode of dealing with complaint and allegation is paralleled in community life by the *alcalde's* personal and prompt dispatch of civil grievances.

The Role of the Union

The *sindicato*, or labor union, is important in making the factory attractive to Cantelenses. The union welded the worker to his job through these obvious ways: it gave him a greater economic return; it allowed the swift and direct airing of grievances; it gave some control over the job and conditions of work; it involved the workers in a set of social relations based on voluntary membership; it taught him some elementary lessons of pressure group tactics and effective organization; it gave the workers closer ties to the nation through the network of a national labor movement.

The union was community-oriented and played a part in many community projects, buttressing the integration of workers into their community. I emphasize the union's ability to aid in the individual's commitments to the factory, not only on the grounds of the wage and work gains but because this estimate of the union's role was made plain to me in late 1954. When the union went into a temporary period of inaction following the overthrow of the Arbenz government (all social groupings connected in any way with the national government had a similar period of suspension until the character of the Armas regime was crystallized), 32 men quit their jobs within a week. This was the largest turnover in the decade and it arose from the real possibility, which did not materialize, that the union was to be totally and permanently abolished.

The net economic advantage of factory work and the character of the occupational role account for the recruitment of the factory labor force and during the last decade for its firm commitment to industrial wage work as a way of making a living. I have attempted elsewhere[1] to generalize on the emergence of a committed labor force on the basis of Cantel's successful experience.

3. SOME LABOR PROBLEMS OF INDUSTRIALIZATION IN EGYPT[1]

From F. Harbison and I. Ibrahim, "Some Labor Problems of Industrialization in Egypt," *Annals of the American Academy of the Political and Social Sciences*, Philadelphia, May, 1956.

Countries such as Egypt which are latecomers to industrialization have at least one great advantage. If they are able to find the necessary capital resources, they can utilize the most advanced technology and machinery which industrialized countries have taken decades to develop. The Egyptian cotton spinning and weaving industry is a case in point. Most of Egypt's mills are new, and many have the very latest machinery which can be bought in the United States, Germany, and Switzerland. As a consequence, some of the Egyptian textile mills, from a physical and technological standpoint, are among the most modern in the world.[2] In striking contrast with their advanced technology, however, is their relatively primitive and wasteful use of manpower resources. This is characteristic of the process of economic development in most countries today. The development of effective human organization lags far behind the introduction of modern technology.

In this article we shall illustrate some of the social consequences of this pattern of economic development by a brief case analysis of the managerial and labor practices of one of Egypt's most modern textile companies. This

[1] Manning Nash, "Recruitment of Wage Labor and the Development of New Skills," *Annals of the American Academy of Political and Social Sciences*, vol. 305, pp. 23–32, Philadelphia.

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[1] The material for this article was collected as part of a broader research program that the authors are conducting in Egypt for the Inter-University Project, which is sponsored by a group of economists from Harvard University, Princeton University, Massachusetts Institute of Technology, the University of Chicago, and the University of California (Berkeley) under a grant from the Ford Foundation.

The opinions expressed in this article are those of the authors and do not necessarily represent the viewpoints of the company or the Egyptian Department of Labor.

[2] In this respect, Egypt's textile industry meets the criterion of some economists for the most appropriate type of industrialization for an economically underdeveloped country. In a recent article, for example, Professors Galenson and Leibenstein argued persuasively, "Successful economic development under present conditions, particularly in the face of gross backwardness, hinges largely upon the introduction of modern technology upon as large a scale as possible."—Walter Galenson and Harvey Leibenstein, "Investment Criteria, Productivity, and Economic Development," *Quarterly Journal of Economics*, Vol. 69 (August 1955), p. 370.

enterprise, which we shall refer to as the "Kafreldawar Company," is located in a rural area about fifteen miles from Alexandria. It is one of several textile enterprises of the "Misr Group," all of which are owned and operated by Egyptians. The factories of the company have been in operation for fifteen years, and they currently employ over ten thousand persons.

In comparison with some other Egyptian enterprises, the company which we have chosen has exceptionally good management. Its technology and machinery are typical of the latest and the best even in the advanced industrial countries. Its labor resources are typical of those available to industry in the town of Kafreldawar and the surrounding rural area. There is the usual superabundance of unskilled and undernourished agricultural laborers, the vast majority of whom are not only illiterate but also afflicted with endemic diseases of one kind or another. The Kafreldawar Company, over a period of fifteen years, has been successful in building from these human resources a stable and permanently committed labor force whose general standards of living are considered to be well above the average for Egyptian factory workers.[3]

KAFRELDAWAR COMPANY WORK FORCE

By 1952 [4] the Kafreldawar Company had a total work force of about 10,300 persons. About 9,400 of these, or over 90 per cent, were hourly paid factory workers, and about 900 were salaried employees. Of these employees, 30 were members of top management (managing director, managers, and submanagers), about 500 belonged to supervision, and the remainder were secretaries or clerks. Obviously, the building of the managerial and labor resources for an enterprise of this size was a formidable task, and it is important here to scrutinize the policies employed by the company in recruiting and developing the various segments of this labor force.

TOP MANAGEMENT

The Kafreldawar Company did not have to start from scratch to build its organization. The top management groups were selected almost without exception from an older and larger Misr textile enterprise at Mahalla which is often referred to as the "mother company." All had a college education or its equivalent; all those connected with production processes were qualified engineers; the vast majority had spent at least one or two years in education at company expense in Europe or the United States; and all were relatively young. With this kind of experienced "top-drawer" management, the company was well prepared to master the technical problems involved in the operation of a modern textile mill.

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[3] Our analysis is based on about sixty interviews with members of the managerial and supervisory organization of the company and a smaller number of key persons in unions and in the Labor Department of the Egyptian government. Most of the interviews were made by I. Abdelkader Ibrahim in Arabic, but a few were conducted jointly by both authors in English. The bulk of the interviews took place in 1953.

[4] On July 23, 1952, the Egyptian Army led a liberation movement which ousted the king. The resulting Liberation government introduced major social and economic programs of development.

The organization of this group, however, was more primitive. Effective decision-making power was concentrated in the Managing Director who had fifteen subordinates reporting to him. Since he extended his personal control to all phases of the business, very little authority and responsibility were delegated downward. Although there was no organization chart and no clearly defined relationships between staff and line departments, the chain of command was apparently quite clear to most members of management, and each appeared to know to whom he should report and who his subordinates were. As one might expect, there was very little downward communication and practically no upward communication between the various levels of this organization. Decisions regarding such matters as transfers or promotions were often made at the top without consultation with those who would be most vitally affected. It was very difficult for individuals in the managerial group to discuss matters of broad policy with their colleagues, and an effort to institute "family meetings" to consider and solve problems of a general nature proved to be fruitless. The communication process between the top management and supervision, furthermore, was quite underdeveloped except on strictly technical questions. In summary, the top management at Kafreldawar might be simply characterized as follows: it consisted of a small, well-educated, socially homogeneous and professionally oriented managerial elite, but it did not function as an integrated team. It was rather a group of individuals with good technical qualifications reporting to a strong boss. It concerned itself primarily with technical rather than with organizational or human problems, and stood more or less isolated from the lower echelons of the salaried workers and laborers.

SUPERVISORS

The five hundred supervisors (assistant submanagers, section chiefs, foremen, and charge hands) were likewise a homogeneous though disorganized group. None were engineers or college graduates, but all were graduates of Egyptian trade schools.

About 20 per cent of the supervisors were former employees of the "mother company" and had been sent abroad for some technical training.

They had constituted the nucleus group of foremen and charge hands when the factory at Kafreldawar was opened in 1938, and in 1952 for the most part held the top supervisory positions such as section chiefs or assistant submanagers. For this group advancement into upper management was not possible because positions at this level were always reserved for engineers or college graduates. In order to boost their morale, the company "promoted" some of these top supervisors to new jobs having the same functions but carrying higher pay and a different title. Those who were still dissatisfied, of course, could often get good jobs in other expanding textile mills, but without the formal educational qualifications, they could never gain access to the managerial class.

The remaining 80 per cent of supervisors were hired at the gate. They learned about job openings mostly from fellow graduates of trade schools, relatives, or friends. Those who could produce birth certificates and school diplomas were usually accepted, and upon passing a required medical examination were given a serial number and had their fingerprints taken. The new recruits were not asked where they would prefer to work nor were they given any induction training. They were not even informed about the wages they would receive nor the section to which they were assigned. In order to get oriented or even introduced to their bosses, most of these recruits had to rely on fellow trade-school graduates or kinsmen who were already employed in the plant. As a typical recruit expressed it, "I was told the name of the section where I was going to work, and I had to ask everybody I met to show me where to go. While I was looking for the location of my job, I came across an old schoolmate and he took me there." Sooner or later, however, the recruits were welcomed by fellow foremen or charge hands who were old schoolmates and, as one of them put it, "This added to our solidarity."

Most of the recruits found that their training in trade school was of very little value on the job. The modern automatic looms in the factory bore little resemblance to the equipment with which they were familiar in school. Since the company had no systematic program of training, the new recruits again had to rely on casual help from their more experienced friends or kinsmen to learn their jobs. Some learned quite successfully; others became discouraged and quit.

Most of those who stayed were critical of the company's promotion practices. The big complaint was that promotions were made on the basis of personal favoritism without proper consideration of skill, merit, ability, or seniority. Another common complaint was that some trade-school graduates were kept on the hourly payroll and were treated like workers.

Most of the supervisors and even some of the administrative staff were participants in the plant-wide union, and many of them became its leaders as a means of gaining personal prestige and higher status within the plant and the community. This sometimes afforded them an opportunity to meet with government officials in Cairo or even to attend as delegates conferences in other countries. Others left the company to become instructors in the trade schools when opportunities became available after 1947. It could be argued that many of these persons left because of the relatively high social status of teachers and government service in Egypt, but our interviews indicated that a more compelling reason, particularly for those who were relatively new in employment, was dissatisfaction with employment at Kafreldawar.

WORKERS

The hiring of the 9,000 workers was a comparatively simple process. Two days each week were designated for recruitment. The applicants waited outside the gate until the personnel officer arrived. He then selected workers on the basis of his experience and personal judgment. Applicants who showed particular alertness or who might appear to be potential troublemakers were passed by. If any applicant showed a letter of recommendation, it would be torn to pieces at once, and he would not be employed. The idea here was "to avoid favoritism." Those applicants who had been previously employed in factories were summarily rejected because the company had an unwritten but firm policy of engaging young workers with no previous industrial experience. It was felt that agricultural workers because of their "simple character" could be more readily trained and easily satisfied. The central objective was to recruit a docile and obedient work force.

Those selected in this fashion were next photographed, fingerprinted, given serial numbers, and passed on for medical examination. The main reason for the photographs and fingerprints was to make sure that no one was hired who had previously been employed by the company. (Job seekers who had been once rejected would frequently change their names.) As a means of reducing turnover, the company wanted to make it clear that anyone who had quit his job would not be eligible for future employment. For the new applicant, however, the greatest hurdle was the medical examination, not because it was particularly rigorous but because of the very high incidence among the village population of diseases such as trachoma, bilharziasis, and ancylostomiasis. Once hired, the factory worker was told to find the section to which he was assigned and to report to work. As in the case of the supervisory recruits, there was no orderly induction procedure nor any formalized training on the job. However, the older workers were skillful in teaching the newer recruits how to behave during their period of probationary employment. For the first six months, the new worker was on probation and could be discharged by the foreman for any reason, but upon recommendation of the foreman, the worker acquired permanent employment status at the end of the probationary period.

According to the supervisors we interviewed, the criteria most commonly mentioned for judging the worker's fitness for permanent employment were as follows: obedience, punctuality and regularity, no complaints from fellow workers, politeness, no talking back, and record clean of sanctions.[5] The objective, obviously, was to recruit and retain docile and submissive labor rather than efficient workmen. Since there was practically no opportunity for uneducated workers to rise into positions of supervision, there was little reason to encourage individual initiative or ambition.

Turnover

For the first eight to ten years, the turnover of labor was very high. No genuine attempt was made by the company to assist those hired to adjust to factory employment. The company customarily employed 30 per cent more workers than needed simply to take care of turnover and absenteeism. Indeed, in a period of fourteen years, a total of 54,000 persons were hired to maintain a "committed" force of slightly over 10,000 workers. In the long run, however, the trial and error method of recruitment and commitment resulted in a permanently committed work force. In recent years, turnover has been negligible. Indeed, in 1952 the company had more workers than it needed, and it might have laid off many of them were it not for legislation which restricted the discharge of labor.[6] Since 1952, however, this problem is being solved by substantial expansion of the factories without increasing the size of the labor force.

Wages and Productivity

The wages of Egyptian factory labor are, of course, very low. For Egyptian textile wage earners, the average take-home pay is about 195 piastres a week, the equivalent of $5.50. The pay at Kafreldawar is somewhat higher. The difference between the income of a textile worker and an agricultural laborer (fellah), however, is substantial. The textile worker might earn in ten weeks the amount the fellah would get in a year, if the peasant worked the maximum period, which is about two hundred days per year.

The company, because of the very low wage rates prevailing in Egypt, has never been much concerned with the productivity of labor; the important consideration has always been to get the maximum productivity per machine. For this reason, it is estimated that, on comparable machines, six to eight workers may be employed in Egypt for every one in the United States. Thus, despite the low wages, the total labor costs in companies such as Kafreldawar are substantial, and some members of management argue that they may be as high or even higher than in Europe or the United States.

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[5] Sanctions are financial penalties imposed upon the worker for such things as tardiness, unexcused absences, carelessness on the job, refusal to follow instructions, etc.

[6] Decree 75/1940, *Journal officiel* (Cairo, Egypt: Government Press), July 27, 1940.

MORALE

The members of top management were generally aware of the deficiencies of its labor force, but they tended to place the major blame on supervision. The supervisors, so top management claimed, did not like to get their hands dirty and preferred white-collar jobs; they had exaggerated notions of the worth of their trade-school education and too great a feeling of superiority over the workers they supervised; they were loath to take responsibility and repeatedly passed on to top management minor decisions which they should have made themselves; in short, they had little ability or feel for handling problems of human relations.

For their part, members of supervision criticized the indolent, slothful, lazy, and untrained workmen whom they had to supervise. The members of supervision were also sharply critical of their superiors, claiming that top management never appreciated the problems faced by foremen and charge hands in dealing with this kind of labor force. The workers, whom we did not interview, were presumably as discontented as the supervisors. Thus the morale of the entire supervisory and labor force was undoubtedly very low.

In comparison with the magnificent factory buildings, the up-to-date automatic machinery, and the extremely efficient plant layout, the wasteful and haphazard techniques of recruiting and training a supervisory and labor force were indeed primitive. Most people in top management, though they had never given much thought to these human problems, were quite frank in recognizing the big gap between technology and effective organization. But, at least before 1952, they were under little pressure to do much about it.

SOCIAL WELFARE AND LABOR POLICIES

At the same time, in comparison with other Egyptian enterprises, the labor policies and social welfare programs of the Kafreldawar Company were fairly advanced. Let us examine them briefly.

In 1952 nearly all of the salaried employees and more than a quarter of the factory workers were living at very low rents in houses or apartments built and owned by the company. These dwellings, grouped into five attractive communities, are well designed and substantially constructed. Schools, playgrounds, sports clubs, and recreational facilities are excellent. Indeed, from a physical viewpoint, the factory buildings and the surrounding company housing would compare favorably with the best in Europe or the United States.

The company also operates a cafeteria which serves three meals a day at greatly subsidized prices. The law requires that any employer hiring more than five hundred workers must provide medical care (including specialists' services), hospitalization, and drugs for all members of the labor force. The law also requires employers to organize classes to teach workers to read and write. This company, however, has gone far beyond the minimum requirements of the law in providing these kinds of services. It also organized a co-operative society for selling groceries and clothing at reasonable cost. In 1952, the company spent a sum equivalent to 20 per cent of the total payrolls for its various social services, and its achievement in this area is widely acclaimed, not only by other employers but by union leaders and government officials as well. Indeed, with respect to social welfare, Kafreldawar is one of Egypt's "show places."

But while the company was spending thousands of pounds to keep its workers happy, it was also making a conscious and studied effort to keep them under firm control. At Kafreldawar, as in most other enterprises in Egypt, the central objective of labor policy was to maintain discipline. We have already noted that the policy of the company in recruitment was directed toward the development of an obedient rather than an efficient work force. This policy was further implemented through the device of sanctions and the control of union activity.

At Kafreldawar, as in other enterprises in Egypt, discipline is enforced by a system of sanctions. For infraction of plant rules, the worker may be given a warning, a cut in pay for a specified period, or dismissal for a flagrant offense such as insubordination. In plants employing over fifty workers, the law requires that the schedule of sanctions be approved by the Department of Labor and that the money deducted from wages as punishment be placed in a special fund to be used for the general welfare of the workers in ways determined by a joint labor-management committee. Before August 1952, however, supervisors at Kafreldawar were given a free hand in making recommendations for these sanctions. This procedure was a potent weapon to keep the workers in line, and, as might be expected, there were many abuses in the use of the sanction power. But so long as the unions were weak, workers had little recourse against such abuses.

Company-controlled Union

Furthermore, the Kafreldawar Company, like other large enterprises, was generally in a position to control if not to dominate what unions there were. Many of the union leaders in fact held positions in the management hierarchy. In some cases they were division heads or assistant department chiefs. The Secretary-General of the company was for a long time legal adviser of the union. The union's office was in the company administration building, and the company provided the facilities for the banking and safekeeping of its funds. Elections of officers were free, but according to the testimony of the persons interviewed, the following procedures were common: (1) Top management would indirectly encourage certain employees to offer their names as candidates for union office. (2) The foremen were then instructed, informally, to persuade workers to vote for these hand-picked candidates. (3) If candidates unacceptable to the management were nominated, the company would persuade them to withdraw, and most would comply in expectation of some future favor.

It was clear that the rank and file always knew who were the company's favored candidates, and almost everyone voted for them. The rationale among the workers was that the union was very weak in comparison with the company and that the company would be more lenient with the workers if they elected officers who had top management's approval. The "demands" of the union were characteristically submitted as "suggestions" to the company. If the management acted favorably on such suggestions, they were put into effect on a unilateral basis by the company as a gesture of paternal benevolence. In short, before the Revolution of 1952, the company had complete control over the machinery of worker protest. Its authority to hire, fire, discipline, and direct the working force was unchallenged. For this reason, top management was never much concerned about labor problems. It simply assumed that its paternalistic personnel practices and its social welfare programs would keep the employees and the workers sufficiently dependent upon the company so that they would not question in any way the manner in which management exercised its prerogatives.

RESPONSE TO THE REVOLUTION

Egypt's Revolution of July 23, 1952, marked the beginning of a new era in the labor and management policies of companies such as Kafreldawar. The new Liberation government enacted legislation designed to encourage unions and to make them more independent of the companies, but at the same time took measures to extend its control over management-labor relations in the large enterprises. For example, the new labor legislation makes the union shop compulsory in establishments where three-fifths of the labor force are union members, and it also requires the employer to check off dues upon the request of the union. It encourages the establishment of joint machinery to handle grievances and to police the system of sanctions. At the same time, the regulations prohibiting strikes were strengthened and the participation of the government in what amounts to compulsory arbitration was extended. Under the Egyptian labor laws, the officers of unions must themselves be workers or employees of the company, and outside professional leadership is prohibited in order to keep the unions from engaging in political activities or movements.[7] Thus the net effect of the Revolution was to give workers a feeling of emancipation from the unilateral authority of the company, and to mobilize their support of and allegiance to the goals of the Liberation. Under these circumstances the unions in the textile mills quite understandably were quick to present their "requests" or "demands" to the companies.

Even before the union at Kafreldawar made its demands known, an unexpected crisis developed which dramatized the labor problem and led to the virtual occupation of the plant by the Army. On August 12, 1952, a mob of demonstrators attacked the plant at the time of changing the night shift and set fire to the administration building, the company garage, and several automobiles. The mob was led mostly by persons not employed by the company, but many of the demonstrators were former employees and workers on another shift. The Army came in to keep the situation under firm control. It was concluded that the attack was instigated by anti-Revolutionary reactionaries who were trying to embarrass the new regime. However, it was clear to the top management at the Kafreldawar Company, and particularly in the government, that this demonstration was built upon the feelings of resentment which the workers had against the company and that measures must be taken to solve some of the labor problems that apparently existed.

Salaried Employees "Suggest"

A few days after this incident, the salaried employees submitted their "suggestions" to the company. Among other things they requested the following: a more definite and regular system of annual salary increases, increased pay and fringe benefits, upgrading to the status of salaried employee of all charge hands paid by the hour, the establishment of a committee to review complaints, and a reduction of the bonus given to members of the board of directors. These matters were resolved, not by collective bargaining, but by joint determination of the company and the government. Most of the requests, except those relating exclusively to management such as the directors' bonus, were granted at least in part.

Union Demands for Wage Earners

Two weeks later the union submitted a long list of demands on behalf of the wage-earning group, the most important of which were: (1) wage increases, fringe benefits, and improvements in working conditions; (2)

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[7] Decree 319/1952 relating to labor unions, *Journal officiel* (Cairo, Egypt: Government Press), No. 157 (bis), December 8, 1952.

provision for annual bonuses and regular increases in pay each six months; (3) upgrading to the status of salaried employee of those skilled mechanics who performed work similar to trade-school graduates; (4) payment of an incentive bonus to the best three workers in each of the production departments; (5) formation of machinery to pass upon sanctions, disciplinary cases, and grievances.

Again with the participation of the government, the company granted most of these demands. The establishment of a disciplinary committee was perhaps the most fundamental concession made. This committee was given full power to decide upon disciplinary action to be taken in accordance with the Rules of Sanctions approved by the Department of Labor. Its composition was as follows: a representative of the Department of Labor as chairman, a representative of the legal section of the company, and a representative of the union.

Significance of 1952 Settlements

These 1952 settlements, which were underwritten by the company, the Department of Labor, and the Army officer in charge of the area, established a new framework of industrial relations at Kafreldawar. In brief, it provided the following: (1) the *right* of workers and employees to have annual wage increases according to a prescribed formula; (2) the *right* of workers and employees to upgrading and promotion on a systematic basis (in this case seniority); (3) establishment of formal grievance procedures whereby the union, along with the company and the government, is a party to control of disciplinary action; (4) full acceptance of the union as an institution functioning within the enterprise and as an agency for presenting demands on behalf of the workers and employees.

Changes in Union Leadership

Along with these changes, furthermore, there have been changes in the leadership of the union. The officers, by and large, are now members of the wage-earning group rather than management functionaries, and company influence in the election of candidates for office has been greatly curtailed. In short, the union at Kafreldawar is stronger than it was before 1952 and a great deal more independent of the company. Its effective power, however, depends not so much on its own economic strength as upon its ability to influence the representatives of the Ministry of Labor and Social Affairs, which plays a strategic role in industrial relations.

New Directions in Company Policy

With this relinquishment of some of its unilateral authority over workers, the company has lately become much more conscious of the need for effective training of both workers and supervisors. It is beginning to think in terms of the development rather than merely the control of its wage-earning and salaried labor force. In the process of present expansion of the factories, the company hired a Swiss consulting firm to set up a program of work organization, job description, and job evaluation that would enable the company to make the best utilization of its labor force and operate its new facilities without hiring additional workers. The Managing Director is planning also to establish a program for training the managerial and supervisory personnel in the handling of human relations. It is apparent that the Kafreldawar Company, having recognized that labor problems are important, is now devoting both energy and resources to bringing its practices of manpower management closer to the levels of its advanced machinery and technology. If this trend continues, the company could be in the future one of the world's most efficient textile manufacturers.

BROADER INFERENCES

If we assume that our case analysis may be fairly typical of that kind of industrialization which utilizes modern technology on a large scale, we can make these tentative observations regarding some of the social consequences of economic development in a country such as Egypt.

Physical and Technical Resources

First, it is comparatively easy for an Egyptian company with adequate capital resources to build and operate very modern plants. The designs for the plant, the processes, and the machinery can be imported from abroad. It is also possible to develop a staff of Egyptian engineers and supervisors who are technically qualified to run the plant, although this may require expensive training in foreign countries in the early stages of industrialization. In this respect, an underdeveloped country has a great advantage in being able to make immediate use of processes and technology which the more advanced countries have taken decades to develop.

Technologists and Human Relations

Second, the recruitment and training of competent technologists does not necessarily lead to the development of an efficient managerial organization. Indeed, the preoccupation of engineers with technical problems may even cause them at the outset to neglect the human factors involved in building and running an effective organization. In this way, the foundations are laid for future labor protest and government intervention.

Behind High Turnover

Third, in a country where there is an abundance of cheap labor, management may have very little incentive to spend time or resources in the initial selection, training, and development of its working force. Thus the initial high turnover and low productivity of the working forces may be more directly a result of underdeveloped management than the unavoidable and inevitable consequence of the adjustment of agricultural laborers to the routines of industrial employment. For example, if the Kafreldawar Company had used even some of the simplest modern personnel practices in selecting, inducting, and training its workers, it might have built a stable working force in five years rather than in fifteen.

Obedience vs. Efficiency

Fourth, in a cheap labor country such as Egypt, employers are initially interested in developing an obedient rather than an efficient working force. They have an incentive to increase the productivity of machines but not of manpower. The very low productivity of labor, therefore, is in large measure a consequence of the lack of investment of time and resources by the employer in training and developing the productive capacities of workers and supervisors.

Outside Pressures

Fifth, in the early stages of industrialization, the employer may be in a position to maintain his unilateral authority over the workers, and he may even be able to capture and dominate the machinery through which worker protest is channeled. Sooner or later, however, the intervention of the government in industrial relations and the development of independent unions which the state may encourage will force the employer to share his prerogatives with outside contenders for control over such protest. At this point, pressures may be generated which force top management to invest more time and energy in effective manpower management. Labor becomes more expensive, and the employer's freedom to hire and fire at will is closely circumscribed. It becomes necessary to develop administrators and supervisors who have skills in managing and developing labor resources. The human factor thus begins to match the technological as a major concern of top management.

Effect of Increased Productivity

Sixth, the ultimate consequence of these pressures is probably the development of better paid, better trained, and much more efficient working forces in industrial establishments; but at the same time it also tends to limit the expansion of employment in the industrialized sector of the country. Within the past two years, for example, the Kafreldawar Company and others like it in Egypt have been able to nearly double their output (through installation of additional factories, more machinery, and better methods of manpower management) without any appreciable increase in their total working force. If the fruits of this increased productivity are widely shared through lower prices of manufactured goods for the consumers, the population as a whole may stand to gain. But if employers are able to maintain prices by collusive arrangements which are further bolstered by protective tariffs, industrialization of this kind may contribute very little indeed to the general welfare.

Management Problems

Lastly, our analysis indicates that the "labor problems" of industrialization are really in large measure "management problems." The recruitment and training of a labor force is a managerial function. If a country wants to develop the productive powers of its people, it must thus plan for the careful development of its managerial resources. It cannot succeed by investing only in plants, machines, and technicians. It must make a substantial investment also in the education and training of human agents in general and in the development of organization builders in particular. And finally, it must create an environment in which management is under constant pressure to grapple effectively with the human factors involved in the introduction and use of modern technology.

4. MAHATMA GANDHI'S VIEWS ON MACHINES AND TECHNOLOGY

From D. P. Mukerji, "Mahatma Gandhi's Views on Machines and Technology," *International Social Science Bulletin,* vol. 6, no. 3, UNESCO, Paris, 1954.

This paper comes out of the conviction that any study of the social changes brought about by technology should be based primarily on an understanding of the conditions of both the society which introduces technology and the society to which it is introduced. If these conditions are crystallized in two systems of values, one which has accepted, and the other which has not accepted "technical progress" as desirable or technological advance as "a self-evident good" (R. K. Merton, *Social Theory and Social Structure,* ch. xiii, p. 317); and further, if the strains of technological advance, which any scheme of technological assistance brings in its wake, must be reduced or eliminated so as to render the assistance genuinely effective, then one of the chief concerns of the sociologist as well as of the technical administrator is the discovery of the terms of the normative system of both countries concerned. . . .

It is disheartening that no formulation of the Eastern value-system has been made by an Eastern sociologist. One reason for this may be that Eastern people are still too deeply involved in their system and, therefore, the technological impact on their basic values is as yet superficial. Another reason may be that those who could formulate and compare the value-systems are the very people who believe in technical advance as a "self-evident good" and, therefore, do not worry about the problem beyond the stage of annoyance with temporary maladjustments which, in their view, a welfare state, or a similar agency or agencies, would benevolently remove sooner or later. . . . [Mahatma Gandhiji] was deeply and primarily concerned with the value-systems, . . . and he put his views very sharply indeed. One may not like his manner of posing the problem, one may consider it as partial, one may dismiss it, if one chooses, as many "educated" men and industrialists of India have chosen. But his statements remain a challenge to the entire problem of technological change and schemes ot technical assistance. . . . From them one might infer that the term "underdeveloped economy," which is the excuse of technical assistance, was inappropriate insofar as it confused the co-existence of two different value-systems by placing them on the assembly-line of historical development in which economic growth, being the supreme value, was subservient to and dependent only upon technological advance. Perhaps, Gandhiji was unfair to the European civilization; it may also be that he did not subscribe to the unilinear concept of history. But it is certain that he had other values and his understanding of India, at least, was unerring. We Indians love to think that Gandhiji's views correctly represent the unformulated values of the vast majority of the Indian population towards social changes. They, as he would say, would welcome change on their own human terms. . . .

Let us follow the development of Gandhiji's ideas. In October 1924, soon after he had broken one of his famous fasts, he gave an interview to a student from Santiniketan, Sir Ramchandran, who questioned him on his views on the place of Art in national regeneration and on machinery. Ramchandran asked (*Mahatma*, vol. 2, p. 212)

R. "Are you against all machinery?"

G. "How can I be when I know that even this body is a delicate piece of machinery? The spinning wheel itself is a machine; a little tooth-pick is a machine. What I object to is the craze for machinery, not machinery as such. The craze is for what they call labour-saving machinery. Men go on 'saving labour' till thousands are without work and thrown on the streets to die of starvation. I want to save time and labour, not for a fraction of mankind, but for all. I want the concentration of wealth, not in the hands of a few, but in the hands of all. Today machinery helps a few to ride on the backs of millions. The impetus behind it is not the philanthropy to save labour, but greed. It is against this constitution of things that I am fighting with all my might."

R. "Then you are fighting not against machinery as such, but against its abuses, which are so much in evidence today?"

G. "I would unhesitatingly say yes; but I would add that scientific truths and discoveries should first cease to be mere instruments of greed. Then labourers will not be overworked and machinery instead of becoming a hindrance will be a help. I am aiming not at eradication of all machinery, but limitation."

R. "When logically argued out, that would imply that all complicated power-driven machinery should go."

G. "It might have to go, but I must make one thing clear. The supreme consideration is man. The machine should not tend to keep atrophied the limbs of man. For instance, I would make intelligent exceptions. Take the case of the Singer Sewing Machine."

R. "But, in that case, there would have to be a factory for making these Singer Sewing Machines, and it would have to contain power-driven machinery of ordinary type."

G. "Yes, surely. But I am Socialist enough to say that such factories should be nationalized or state-controlled. They ought only to be working under the most attractive and ideal conditions, not for profit, but for the benefit of humanity, love taking on the place of greed as the motive. It is an alteration in the conditions of labour that I want. This mad rush for wealth must cease and the labourer must be assured not only of a living wage but a daily task that is not a mere drudgery. The machine will, under these conditions, be as much a help to the man working it as to the state, or the man who owns it. The present mad rush will cease and the labourer will work, as I have said, under attractive and ideal conditions. This is but one of the exceptions I have in mind. The sewing machine had love at its back. The individual is the one supreme consideration. The saving of labour of the individual should be the object and honest humanitarian considerations, and not greed the motive. . . . Therefore, replace greed by love and everything will come right."

Next morning the interview was continued. Ramchandran persisted:

R. "If you make an exception of the Singer Sewing Machine and your spindle, where would these exceptions end?"

G. "Just where they cease to help the individual and encroach upon his individuality. The machine should not be allowed to cripple the limbs of man."

R. "But I was not thinking just now of the practical side. Ideally would you not rule out all machinery? When you except the sewing machine, you will have to make exceptions of the bicycle, the motor-car, etc."

G. "No, I don't, because they do not satisfy any of the primary wants of man; . . . Ideally, however, I would rule out all machinery, even as I would reject this very body, which is not helpful to salvation and seek the absolute liberation of the soul. From that point of view, I would reject all machinery, but machines will remain because, like the body, they are inevitable. The body itself, as I told you, is the *purest piece* of mechanism; but if it is a hindrance to the highest flights of the soul, it has to be rejected.". . .

The "ideal" pattern of Hindu values was never forsaken by Gandhiji. It was woven round "wantlessness." How could technology and machines geared to the production of goods for the satisfaction of wants, which created more wants, joint wants, derived wants, the infinite hyperbola of wants, be consonant with the pattern of Indian norms? How could such norms square for that matter, with Economics, grounded as it was on wants and their satisfaction? If absolute liberation of the soul from the body be the utter sum of existence, then Gandhiji, and with him, every Hindu who was aware of his ancestry, would raise the eternal query: Why this craze for machinery? Why machine-civilization at all? Other problems such as machines helping a few to ride on the back of millions, the concentration of power and wealth, of justice for the labourer as man, securing attractive conditions of life for him and of giving him security of employment, etc. etc. would be subsidiary. These latter, in Gandhiji's opinion, ultimately hinged upon non-possession, wantlessness, subordination of body and bodily wants to the need of the soul's liberation from its physical encasement, which was *the* end.

These subsidiary problems, however, were far from socially insignificant. In the Gandhian view of life, they were related to the means. To many "educated" Indians they were the ends, or the primary values. Gandhiji had many opportunities of discussing them with those who were more sensitive to the needs and ideas of the day. Rabindranath Tagore's objection was of a different type, but it was met by the logic of means. The poet had written in 1925 against the charkha (the spinning wheel), because he felt that it would bring about a deathlike sameness in the nation. Gandhiji met this argument on the highest level. Taking his cue from the Hindu philosophical conception of oneness, identity, or sameness, which Sankar had carried to its logical extreme, Gandhiji held that "behind a variety of occupations there is an indispensable sameness also of occupation." After inveighing for a while against exploitation both by European and Indian manufacturers, Gandhiji conceded: "Machinery has its place; it has come to stay. But it must not be allowed to displace the necessary human labour. An important plough is a good thing. But if by some chance one man could plough up by some mechanical invention of his the whole of the land of India and control all the agricultural produce and if the millions had no other occupation, they would starve, and being idle, they would become dunces, as many have already become. There is hourly danger of many more being reduced to that unenviable state. I would welcome every improvement in the cottage machine but I know that it is criminal to displace the hand labour by the introduction of power-driven spindles unless one is at the same time ready to give millions of farmers some other occupation in their homes." (*Young India*, 5 Nov. 1925; *Mahatma*, vol. 2, p. 283.) Here was argument on the purely economic level of means, that is, of employment and unemployment. (Also, vol. 4, 34, p. 238–9.) To a modern Western economist it may appear to be old-fashioned. He thinks that he has devised excellent measures against various types of unemployment, cyclical, structural, frictional, seasonal, and all that, and he is not worried if even under full employment two to five per cent are unemployed. But Gandhiji was not to be deluded by such theories and measures emerging out of the practices of countries that had been wedded to industrial and technical civilization, that had colonies to exploit and accepted competitive values in production, trade and commerce. The essence of Gandhiji's concession in this open letter to Tagore is, however, historical. That is to say, so long as "some other occupation in their homes" was not available—and it was not likely to be available in that historical context, or in the near future, because imperialist exploitation would not allow India to create alternative occupations—Gandhiji would stick to the spinning wheel and be against the displacement of labour by machinery. In other words, India in her present context should have labour-intensive economy for the sake of full employment.

Gandhiji was very respectful towards Tagore, and as we have seen met the poet's cultural charge with economic arguments. But he was not so soft towards the Indian Communist M. P. Mr. Saklatwala. . . .

He wrote:

"For unlike Saklatwala, I do not believe that multiplication of wants and machinery contrived to supply them is taking the world a single step nearer its goal. Comrade Saklatwala swears by the modern rush. I wholeheartedly detest this mad desire to destroy distance and time, to increase animal appetites and go to the ends of the earth in search of their satisfaction. If modern civilization stands for all this, and I have understood it to do so, I call it satanic and with it the present system of government, its best exponent."

Then follow some sentences which would remind one of the wrath of prophets, but with a difference. "I would destroy that system today, if I had the power. I would use the most deadly weapons, if I believed that they would destroy it. I refrain only because the use of such weapons could only perpetuate the system though it may destroy its present administration. Those, who seek to destroy men rather than their manners, adopt the latter and become worse than those whom they destroy under the mistaken belief that the manners will die with the men. They do not know the root of the evil."

The last paragraph seems to retain its pertinence today in spheres wider than the Indian. The points to be noticed in Gandhiji's reply to Saklatwala's appeal are Gandhiji's firm faith in wantlessness as a cardinal human virtue, and his objection only to the "modern rush," in which he included both the Western and the Indian values of the day. We may further note his association of modernism with the British Government in India. Strictly from the point of view of the propagation of an unswerving faith, this mixture of basic values with nationalism was excellent. A sociologist would not cavil at it. Technological values are usually associated with the nationalist values, particularly in the Eastern countries in the period of their anti-imperialist struggle which centres in their opposition to the obstacles that imperialism places in their economic growth, and also in the period of economic advance which is held to be possible only with the help of technology. But it is equally understandable that nationalist, anti-subjectionist motives and attitudes should be integrated with the basic values which are, or are interpreted to be, specific to the culture of the nation. While it is true that in this extract no reference is made to the Indian-ness of the objection to the modern rush and the argument appears to rest on the personal level, it is apparent, as it certainly was to the Indian of 1925, that it was a typically Indian argument securely grounded on the Indian philosophy of life, . . . non-possession, enjoyment through giving away.

We must repeat that Gandhiji collected other arguments round this basic objection to machines. They were mainly what we would call sociological arguments on the score of excessive population on land, of idle labour, of bad distribution of wealth, benefit to the nation, that is to say, the welfare of the people. He referred to unemployment again and again, to bad health, unwholesome food, and to the decay of art. He categorically stated that labour had a unique place in swaraj, or independence, and formed its content. Each argument depended on another and the whole formed a pattern of positive values. In 1935, on 23 April, he said after opening the first All-India Village Industries Exhibition at Indore: "The reason why our average life-rate is deplorably low, the reason why we are getting more and more impoverished is that we have neglected our 100,000 villages. We have indeed thought of them, but only to the extent of exploiting them. We read thrilling accounts of the 'glory that was Ind,' of the land that was flowing with milk and honey; but today it is a land of starving millions. We are sitting in this fine pandal under a blaze of electric lights, but we do not know that we are burning these lights at the expense of the poor. We have no right to use the lights if we forget that we owe these to them." Gandhiji would seldom forget to remind his audience of their responsibility towards the people. . . .

On 22 October 1937 he inaugurated the Educational Conference at Wardha and developed his ideas of education through handicrafts. It was a new setting for his constructive programme—an integration of living in love, with efficiency and independence, without exploitation, conflict and poverty, and with education of the body and mind. In expounding his thesis, he said:

"Then, take the question of machinery. I think that machinery is not necessary for us at all. We should use khadi (home-spun cloth); and, therefore, we do not require mills. We should try to produce all the necessary cloth in villages, and we need not be the slaves of machines. I am afraid, by working with machines we have become machines ourselves, having lost all sense of art and handwork. If you still think that we cannot do without machines, the scheme (of new education) I have placed before you will be futile. You wish to keep our village alive by means of machines and think of imparting education to the village children through them. Machines will only help in making all the thirty-five crores of people unemployed. If you think that machines are really indispensable, you must reject the scheme and suggest a new one." (*Mahatma*, vol. 4, p. 238–9.)

In 1946 India was passing through a severe food crisis. Gandhiji offered advice to those who sought it. There were suggestions and counter-suggestions. Even in those dire days he would not move from his fundamental ground. In one of his replies he said:

"I regard the existence of power wheels for the grinding of corn in thousands of villages as the limit of our helplessness. I suppose India does not produce all the engines and grinding machines. . . . The planting of such machinery and engines on a large scale in villages (a suggestion made by a correspondent for resolving the food crisis) is also a sign of greed. Is it proper to fill one's pockets in this manner at the expense of the poor? Every such machinery puts thousands of hand *chakkis* (grindstones for corn) out of work, and takes away employment from thousands of housewives and artisans who make these *chakkis*. Moreover, the process is infective and spreads to every village industry. The decay of the latter spells too the decay of art. If it meant the replacement of the old crafts by the new ones, one might not have much to say against it. But this is not what is happening. In the thousands of villages, where power-machinery exists, one misses the sweet music in the early morning of the grinders at work. But to come to the main point. Whilst I hold that these power engines are, at present, being put to wrong use, it would be some compensation if these engines, in addition to their present use, were also used to pump water out of the rivers, tanks and wells for irrigation." (*Mahatma*, vol. 7, p. 71–2.)

Probably the most comprehensive and yet succinct account of the place of machinery in the context of independence was written by Gandhiji in the *Harijan* of 15 July 1946. It was a clarification for the benefit of Congressmen of his concept of independence. He painted a glorious picture of self-sufficient villages, giving free and voluntary play to mutual forces, highly cultured in the sense that there every man and woman knows what he or she wants and, what is more, knows that no one should want anything that the others cannot have with equal labour, a society based on the living force of truth and nonviolence, a society not like a pyramid but like "an oceanic circle." [1]

On 31 July 1946 Gandhiji addressed a conference of Ministers of Industries of different states in Poona. There he clarified his conception of village industries and referred to the imbalance between town and village economies and the need for establishing justice in their relation. In that connexion he came to a fairly elaborate explanation of what he meant by machines. Sir D. G. Tendulkar, the author of *Mahatma*, gives the following summary: "'Ours has been described as the machine age,' remarked Gandhi, 'because the machine dominates our economy. What is a machine? One may ask. In a sense, man is the most wonderful machine in creation. It can neither be duplicated nor copied.' He had, however, used the word not in its wider sense, but in the sense of an appliance that tended to displace the human or animal labour instead of supplementing it, or merely to increase its efficiency. That was the first differential characteristic of the machine. The second characteristic was that there was no limit to its growth or evolution. That could not be said of the human labour. There was a limit beyond which its capacity or mechanical efficiency could not go. Out of this circumstance arose the third characteristic of the machine. It seemed to be possessed of a will or genius of its own. Machine was antagonistic to man's labour. Thus, it tended more to displace man, one machine doing the work of a hundred, if not a thousand, who went to swell the army of unemployed and underemployed, not because that was desirable, but because that was its law. In America it had perhaps reached the extreme limit. He had been opposed to it not from today, but even before 1909, when he was in South Africa surrounded by machines. Their onward march had not only impressed him, but had repelled him.

"'It then dawned upon me that to suppress and exploit the millions, the machine was the device par excellence; it had no place in man's economy if, as social units, all men were to be equal. It is my belief that machine has not added to man's stature and it will not serve the world, but disrupt it, unless it is put in its proper place. Then I read Ruskin's *Unto This Last*. . . . I saw clearly that if mankind was to progress and to realize the idea of equality and brotherhood, it must act on the principle of *Unto This Last*.'

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[1] "I may be taunted with the retort that this is all Utopian and, therefore, not worth a single thought. If Euclid's point, though incapable of being drawn by any human agency, has an imperishable value, my picture has its own for mankind to live. Let India live for this true picture, though never realizable in its completeness. . . . In it, there is no room for machines that would displace human labour and that would concentrate power in a few hands. Labour has its unique place in a cultured human family. Every machine that helps every individual has a place. But I must confess that I have never sat down to think out what that machine can be. I have thought of Singer's Sewing Machine. But even that is perfunctory. I do not need it to fill in my picture." (*Mahatma*, vol. 7, p. 201–2.)

"In the machine age, this principle had no place. Under it the fittest alone survived, to the exclusion and at the cost of the weak. 'But that is not my picture of independence, in which there is room even for the weakest,' observed Gandhiji. 'That requires that we must realize all available human labour, before we entertain the idea of employing mechanical power.' " (*Mahatma*, vol. 17, p. 214–15.)

We have traced the development of Gandhiji's ideas on machines, and on machine-civilization and found that despite many concessions to the "proper" use of machines his values were definitely opposed to those which make for technological civilization and are made by it. By "proper" he meant, positively, that which was prompted by love and good for humanity, and negatively, what did not lead to concentration of wealth in a few hands and inequality, to centralization of power, to urbanization, to unemployment, to political, economic and social exploitation. These evils, which in his view, were the characteristics of the modern society, with its American apogee, were the consequences of the large scale use of machines, and they had to be fought with vigour. To that extent he was placing Indian (Eastern) against Western (Euro-American, modern) values. It was certainly not a case of revivalism, but a clear statement of a principle of social organization which was different from the one that had succeeded in imposing itself on the strength of political suzerainty. His minimal idea was to establish co-existence of different social systems, on the basis of equality, though the prophetic strain that came to him in the course of his experiments with Truth led him to think that the values he propagated would also be good for the Western world. We will leave it to the Western sociologist to ponder over this issue. An Indian sociologist can only mention that Gandhiji's protagonism of Indian values was not a manifestation of the romantic agony of nationalist historians, nor was it a reactionary, obscurantist throw-back. It is submitted here that he was a revolutionary and what a revolutionary in India should be, viz., an Indian revolutionary, that is, one who would first be steeped in Indian realities and then evaluate the nature of changes in social realities in order to create fresh norms. Gandhiji did not go to the past: in fact, he was not an Indologist; he only went to the roots and the sources. And "the deeper you go to the root the more radical you become."

At this stage it will be relevant to note the revolutionary elements in his views. Their importance arises from the problem before us, that we here must consider the conditions under which technological change can take place without causing the various tensions and frustrations which bring about aggression, violence, and war, which lead to mental unhealth.

In other words, we must ask ourselves whether technology cannot but generate these evils; whether technology should always depend upon wants and their increase and bring about a state of culture in which material wants are king. The inner significance of Gandhiji's concessions to the use of machines, that is to say, the logical meaning of the term "proper" use, is that they do not, and need not, go together. It is perfectly possible, in Gandhiji's opinion; and it is also logical to assume under stated conditions, that technology can be introduced into India without upsetting the Indian pattern of values. These conditions are non-possession, aparigraha, the "oceanic" constitution of Indian independence in terms of self-sufficient villages with their group-existence fulfilled through the panchayats, bread-labour, sharir-srama, with its concomitant of the dignity of labour symbolized in *khadi, sarvodaya,* that is, total awakening or uplift, and of course, nonviolence and Truth, that is satyagraha. . . .

Thus the Gandhian conclusion in regard to machines and technology is logical if one accepts the postulates that India has a separate norm of values—with the hidden assumption that values determine conduct—that she has a separate principle of social organization which would be disturbed and even destroyed by large-scale use of machinery for greed and profit, and that a proper use would presuppose certain attitudes, some traditional and others not, but all working in alliance, and also a type of State that would own and control large machineries, if they were indispensable for defined purposes. Otherwise, the machineries to be used would be of a special type suitable for removing the drugery of handicraft and improving its quality, if possible. They would operate in the general context of de-centralized economy, in close alliance with agriculture. Gandhiji would thus remove the stings of Capitalism and Socialism alike.

In this author's opinion, Gandhiji's views have to be carefully studied before any scheme of technical assistance and large-scale technological development is initiated. While it is very true that among certain strata and sections of the Indian people these views appear strange, even though lip-service is paid to them, and that such people would want to initiate rapid technological change in the name of economic advance, evolution and progress, it is also clear that an unintelligent injection of technology would so disturb the existing social pattern of human relations that work would cease to be associated with joy and workmanship, that skill would be replaced by efficiency, that "the public identity of the job" would be lost, that scientific management and discipline would squeeze the labourer of all humaneness, and that a new instrument of social power would "teach docility" or "break the intransigence of workers," all the time keeping greed, profit and more profit in the background, beyond the sight of those who are to be immediately benefited by higher wages, better conditions of living, welfare-measures and the like (*Social Theory and Social Structure*, R. K. Merton, p. 318–22).

In other words, the sociologist would do well to study the sociology of the demand for technology in India and the sociology of its supply. Fortunately, the Indian masses are not yet fully taken in by the technological values. They are being acted upon by technology, and they are showing healthy, normal reactions to the injection by absenteeism, inattentiveness, a sort of lackadaisical attitude towards work in the factories, unpunctuality, the so-called absence of pride in work and workmanship, but unfortunately, quite often in accidents and ill-health. Even strikes, which are bemoaned as symptoms of industrial conflict, can be traced to the search of the soil-bound peasantry of India for mental and social peace in holiday, away from the scene of work, the din of factories and technology, to the villages where the pattern which they know and instinctively feel to be right, rules even today.

An Indian sociologist cannot thus help questioning the manner and the possible hidden motivations of a technological advance, of those who want it and those who supply it. He can, at least, categorically state, with Gandhiji, that if change is inevitable, let it come in the shape of certain types of machines, at the proper time, in the proper context; and that if large-scale use of machinery is unavoidable, let it be owned and managed by the State, a new form of State. Judging from experience, he cannot share Gandhiji's hope of an interim trusteeship by the fortunate few. In short, the whole problem of technological advance in India, which, let it be repeated, is undeveloped only in the purely technological sense, and therefore, in the sense of being more socially integrated and less fragmentized, has to be studied from the points of view of both the types of machinery to be introduced and of the types of people who would accept them with due regard to the motivations of introduction. In India, human beings are not yet atomistic, so that no functional specification in the most common productive processes, which are those of agriculture, is possible. Nor has it occurred in many industries. In India, no productive section of society is "universalistic," that is, only very few "criteria possibly present in any segment of the population without regard to previous social relationships or membership in irrelevant groups" are available. In India, human relations are affective rather than rational and impersonal. The normative system suitable for the industrial mode of production through large-scale use of machines is thus not the normative system of India. A matter of additional importance is the fact that this normative system has combined with nationalism, anti-imperialism, and Gandhiji's interpretation of independence to convince some people that it is still valuable. So change must take account of these facts in order not to produce the same evils to which the West has been an heir.[2]

5. TECHNOLOGY AND PRODUCTIVITY IN THE SOVIET UNION

From J. G. Gliksman,[1] "Soviet Labor and the Question of Productivity," *Monthly Labor Review*, vol. 80, no. 6, U. S. Department of Labor, June, 1957.

The Soviet rulers have at all times insisted upon the supreme importance and urgency of improving the efficiency of labor in their country—by increasing labor productivity, lowering the cost of production, and improving the quality of the products. One cannot exaggerate the extent to which, year after year, these problems have preoccupied government, political, and trade union organs. There have been doctrinal as well as economic reasons for this preoccupation. Soviet theorists consider the productivity of labor an ideological litmus paper which can test the validity of one of the basic Marxist theories.

According to official theory, progress in the evolution of human society consists in the development of new social systems which are an improvement over their predecessors. The main criterion of improvement is the increasing productivity of labor. Private forms of ownership of the means of production and the capitalist methods of distribution are held to be incompatible with modern technical productive forces which are collective and social in character. This antagonism is regarded as a brake on the rise of labor productivity. But the antagonism disappears in the socialist system, under which—it is even claimed—there operates an economic "law" which insures a steady and rapid growth in the productivity of labor.[2] The socialist system will presumably create an abundance of goods which will constitute "the material-technical base" for the transition from socialism to communism, with its principle of distribution "according to needs." This vision of a Communist millenium, achieved through increased productivity of labor, constitutes one of the most important Soviet ideological dogmas.

Although the insistence on theoretical premises has never weakened,

[2] Most of the quotations from Gandhiji's writings have been taken from D. G. Tendulkar's monumental biography, *Mahatma*, seven volumes of which are available at the time of writing, the eighth being in press.

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[1] Staff member, Social Science Division, The Rand Corp.

[2] Politicheskaia ekonomia, Uchebnik [Political Economy, A Textbook], Moscow, 1955, 2d ed. (pp. 453–455).

economic considerations were undoubtedly the chief and most important grounds for the great concern of the Soviet regime for higher labor efficiency. Labor productivity in pre-Revolutionary Russia was only a fraction of that in Western industrial countries. In the early period of the Revolution, it fell to a level which jeopardized even the physical survival of the population.[3] The task of relieving immediate distress was eased in the New Economic Policy period. But after the initiation in 1928 of the rapid industrialization drive, under the Five-Year Plans, success or failure in the field of productivity increasingly meant the success or failure of these plans.

Among the factors contributing to the growth of labor productivity, Soviet authorities assign first place to technological progress. The Soviet Union, it is estimated, is devoting more than a quarter of its gross national product to capital investment, with striking emphasis on heavy industry.[4] Soviet industrial equipment, as a whole, has undoubtedly undergone vast changes since the initiation of the Five-Year Plans, when handwork and primitive technique prevailed. Exhortations to continuing rapid progress in technology and concern over incomplete mechanization and insufficient utilization of available machinery, are ever present in Soviet writings, speeches, and resolutions on economic problems. There is almost a deification of technology in the Soviet Union.

But the Soviet authorities have been aware that any increase in labor productivity would depend also upon the quality of labor. Improvement of the skills and of the educational and technical level of workers has thus been a continuous concern of the Soviet authorities. When one takes into consideration the really enormous task of training and adapting many millions of backward peasants to modern industry, the Soviet achievement in this respect is truly amazing, although the colossal social cost of this achievement should not be overlooked.

But the quality and quantity of a worker's output depend on much more than his training and skill; they depend, in the last analysis, on the human factor, on the worker's willingness to work. The simplest—and crudest—device for obtaining the worker's cooperation is to compel him to behave in a specified manner by the use of administrative rules and disciplinary laws. For many years the Soviet authorities sought, by imprisonment or partial deprivation of wages, to restrain labour turnover, absenteeism, lateness, and other violations of "labor discipline." [5] But the Soviet leaders seemed, at the same time, to be aware of the limitations of coercion, of the fact that improved performance could be attained only through a system of incentives.

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[3] S. G. Strumilin, Zarabotki i proizvoditel'nost' truda v russkoi promyshlennosti v 1913–1922 [Wages and Productivity of Labor in Russian Industry, 1913–1922], Moscow, 1923 (p. 56).

[4] Abram Bergson and Hans Heyman, Jr., Soviet National Income and Product, 1940–48, New York, Columbia University Press, 1954 (p. 105); U. S. Library of Congress, Legislative Reference Service, Trends in Economic Growth. Prepared for the Congressional Joint Committee on the Economic Report (85th Cong., 2d sess.), Washington, 1955 (table X–3, p. 284).

No extensive Soviet studies on industrial psychology are available. The Soviet psychologists are, however, acquainted with the research in labor psychology conducted in the West, and particularly in the United States. Whereas they are very critical of it, they are willing to profit from it. A recent article in the Soviet journal of psychology points out the need to create a Soviet school of labor psychology.[6]

Devices for Improving Productivity, 1928–1955

But even without an elaborate theoretical approach, the Soviet authorities have developed in practice the most diversified methods of influencing the economic behavior of Soviet workers. Among these are ideological, honorific, and material incentives.

Initial appeals of the Soviet Government for dedication to the good of the community and intensified effort toward the creation of a society in which social justice would prevail were not ineffective. But ideological incentives probably reached their peak of effectiveness during the First Five-Year Plan (1928–32). Since the late 1930's, disillusionment, loss of faith, and indifference have become widespread. Also, the attempts to evoke among the workers a sense of "ownership" with regard to the enterprises where they are employed can hardly be considered successful.

In spite of the limited tangible success of ideological and social incentives, the authorities have never abandoned this type of appeal. Their tenacity cannot be explained simply as an obstinate adherence to old, obsolete, and already vacuous ideological tenets. Without being a primary motivation, ideological incentives do affect some workers; once the workers have entered, for their own materialistic reasons, the course recommended by the authorities, they may rationalize their choice in accepting as their own the idealistic motivations suggested by the authorities.

Social incentives are supplemented by an elaborate system of prestige symbols and honorific distinctions (medals, titles, and so on), which are calculated to appeal to the common human need for approval, respect, and standing in the community. At the same time, the Soviet authorities foster and manipulate a moral pressure in the form of organized ridicule and condemnation directed against undesired behavior. The press, radio, television, workers' meetings, and other media of publicity are used for this purpose. If, in recent years, the actual effect of these methods on the workers' economic behavior has declined, it is still by no means insignificant.

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[5] For the author's analysis of recent changes in labor discipline laws, see Recent Trends in Soviet Labor Policy, Monthly Labor Review, July 1956 (p. 767).

[6] D. A. Oshanin, Puti razvitia psikhologii truda v kapitalisticheskikh stranakh [Directions in the Development of Labor Psychology in Capitalist Countries]. (*In* Voprosy psikhologii [Problems of Psychology], November–December 1956, pp. 153–160.)

The predominant role in workers' motivation, however, clearly belongs to material incentives. Material recompense has become the most effective single influence on the performance of the worker in the Soviet system, as in the capitalist system. Material incentives for Soviet workers are provided chiefly by the wage policy: wages depend on the quantity and quality of the goods produced, on the worker's skill classification, the nature of his work, and its importance in the national economy.

It cannot be denied that Soviet methods of controlling labor have proved effective in many ways. Recognizing that men's impulses never stem from a single source, the Soviet policy has been to apply a combination of all the approaches outlined. By manipulating all such control levers, the regime has reaped cumulative benefits and has achieved many of its pragmatic objectives in the field of labor productivity. . . .

Labor Shortage

The particular concern among Soviet officialdom about labor productivity is caused at the present time on one hand by the declining rate of growth of labor productivity in recent years and on the other, by a shortfall in labor supply which the country faces. . . .

The Soviet leaders are well aware of the obstacles that economic progress will meet because of the labor shortage. They attempt to overcome such obstacles by emphasizing the technological factors that could lead to increased labor productivity. Soviet officials point out the increasingly important role to be played by automation, telemechanics, electronics, industrial electrification, industrial chemistry, the industrial uses of atomic energy, and so on. Bulganin has said that the Soviet Union is standing on the threshold of a new scientific, technical, and industrial revolution which greatly exceeds in significance the industrial revolutions that accompanied the appearance of steam and electricity.[7]

Reforms in Industrial Relations

But even the technological progress achieved to date has made reforms in Soviet industrial relations overdue. The Soviet leaders show more and more awareness that a skilled worker's good will and morale are indispensable in modern industry. The first indication of a shift toward a more liberal labor policy became evident in the early 1950's when the enforcement of the labor discipline laws became visibly relaxed. Ultimately by the decree of April 25, 1956, court penalties for violation of labor discipline were altogether abolished.[8]

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[7] Nikolai A. Bulganin, O zadachakh po dal'neishemu pod"emu promyshlennosti, tekhnicheskomu progressu i uluchsheniu organizatsii proizvodstva, [Concerning the Tasks for the Further Rise of Industry, Technical Progress, and Improvement of the Organization of Production]. Report to the Plenum of the Central Committee of the Communist Party of the Soviet Union July 4, 1955, Moscow, 1955 (p. 10).

The search for an improvement in labor morale has also found expression in the promulgation of some recent labor and welfare laws. During 1956 and the early months of 1957, the Soviet Union increased the abysmally low pensions for the old and the permanently disabled,[9] raised the wages of the lowest paid workers,[10] revised the rules governing the procedure for examining labor disputes,[11] and shortened the workweek from 48 to 46 hours, by reducing from 8 to 6 hours the work on Saturdays and days preceding holidays.[12] It was also promised that the workweek will gradually be shortened during the current Five-Year Plan (1956–60) to 40–42 hours.[13]

All these measures obviously aim to gain the worker's cooperation, to give him a greater feeling of security, and to enhance his efficiency in a modern industrial enterprise by giving him more opportunity and time for rest, and by improving his skill through study and training. In addition, there is great emphasis in Soviet writings—although not yet much action —on the need to provide other indirect incentives, in the form of greater regard for the worker's welfare, particularly in respect to housing and factory eating places.

Among the many reforms under consideration, the most important and radical one affects the wage system, now in a state of extreme disorder. A thorough overhaul of this system has long been overdue: The basic wage structure, originally introduced in 1931, has after years of makeshift changes and ad hoc adjustments become cumbersome and ineffective, with 1,900 different wage scales in operation in industry and in transport.[14] But the average worker actually earns and receives about twice as much as his scheduled standard wage. The excess over his basic standard wage comes from progressive piece rates for overfulfillment of his work norm (which is apparently low) and from a maze of additional bonuses and premiums by now largely without incentive effects.[15]

[8] See footnote 5.

[9] Vedomosti Verkhovnogo Soveta SSSR [Law Gazette of the Supreme Soviet, USSR] (hereafter cited as Vedomosti), 1956, No. 15, Article 313.

[10] Pravda, September 9, 1956.

[11] Vedomosti, 1957, No. 4, Article 58.

[12] Vedomosti, 1956, No. 5, Article 135.

[13] Directives for the Sixth Five-Year Plan, 1956–60. (*In* XX S"ezd kommunisticheskoi partii Sovetskogo Soiuza. Stenograficheskii otchet [The Twentieth Congress of the Communist Party of the Soviet Union. A Stenographic Report], Moscow, 1956, p. 475.)

[14] A. Volkov, Nashi zadachi v novom godu [Our Tasks in the New Year]. (*In* Sotsialisticheskii Trud [Socialist Labor], January 1957, p. 5.)

[15] Ibid., p. 4 et seq.

A special State Committee on Labor and Wages was created in 1955 to simplify and rebuild the whole wage structure.[16] The official reformers intend to force the workers to greater efforts by raising the work norms to a level reflecting the technological progress of recent years, and by raising the basic wage rates simultaneously, but not necessarily commensurately. Thus the worker, in order to keep his earnings at the present level, will have to produce more.

The reform of the wage structure is not an easy job, and the new committee is proceeding very cautiously. It is true that in the construction industry the reform has been completed and that it is well advanced in a few other branches of industry, such as nonferrous ore mining, and in certain scattered plants. Before proceeding with a general revision of wages and norms, the committee decided to conduct experiments in 14 major machine plants. The results were to provide a pattern for the whole country.[17] The experiments have not been very successful or encouraging. Lazar Kaganovich, the first chairman of the Committee on Labor and Wages, and one of the leading political personalities of the USSR, left his job after a year in office and was replaced by a less well-known figure.[18] Last October, according to some persistent reports, an attempt to raise the work norms in one of the experimental factories (the Kaganovich Ball Bearing Plant in Moscow) provoked a sitdown strike. It may be worthy of note that work norms were one of the major issues igniting the workers' uprisings in East Germany in 1953 and in Poznan in 1956.

In summary, it may be said that the reforms discussed here were dictated by the imperative need to adjust labor policy to the requirements of the social changes brought about by technological progress and to the pressure of an impending labor shortage. While most of these reforms have benefited the workers, this cannot be said of the wage reform. It is too early to predict its ultimate effect, but as far as its trend has become apparent, it is primarily designed to maximize labor productivity at the expense of greater physical and mental effort by the workers.

The Soviet Union faces great difficulties in keeping up the previous rate of economic expansion. There is increasing recognition on the part of Soviet leaders that labor supply and performance are presently among the weakest aspects of the Soviet economy. Whether the current efforts of the Soviet regime in the field of industrial relations will bear fruit remains to be seen.

[16] Vedomosti, 1955, No. 8, Article 196; and 1956, No. 1, Article 4.

[17] A. Volkov, op. cit.

[18] Vedomosti, 1956, No. 13, Articles 281 and 282; No. 15, Article 325.

PART FOUR

HOW TO THINK ABOUT IT: TECHNOLOGY AND HUMAN VALUES

INTRODUCTION

We now turn to a summary discussion of how the social sciences in general approach the subject of this book. In other words: How far does the systematic thinking of social science recognize and integrate the *technological component* in our society, and what is still lacking? The author's assumption is that modern man needs *both* more knowledge and more rigorous thinking in this field.

The accelerated process of growing up which for the individual human being we commonly call adolescence is perhaps our closest analogy to what is happening to modern Man both as thinker and as doer. We all know that many things confuse the adolescent besides the novel intensity of his emotions. His world is suddenly very much larger. The "life space" of the individual, as Kurt Lewin would call it, is expanding at a dizzying—and gratifying—rate. He is able to move farther and faster—by motorcycle or sports car, for example, and with enormously enhanced ego satisfaction. Physical action has an almost metaphysical excitement—even knowledge becomes a breathless experience. But a less exhilarating side of the coin of adolescence is the sudden appearance and multiplication of responsibilities, plus the hovering presence of "great expectations," making the heart tremble with fear—and pride.

Add together these forces and calculate the *resultant*, as the physicist would say, and you have the life motion of the adolescent, characterized by wide swings between periods of intense activity—both mental and physical—and periods of lag and lethargy. Paralleling the above "motions" are swings between dizzy self-confidence and blank despair—with many blurry areas of mere bewilderment in between.

Like the adolescent, modern Man has been experiencing unprecedented enlargements in his living space. As we saw in the section on perspectives, in the light of history and prehistory, these enlargements and accelerations are almost beyond belief. And like the adolescent Man alternates between confidence and fear—with in-between areas of bewilderment.

Faced with these sudden enlargements, few of us, unhappily, achieve the calm and the competence of an Astronaut Shepard. But his experience is a good instance of the point. Shepard enlarged his own living space in the span of a few short years from a small New Hampshire town to interplanetary space.

But returning to Man: Into the expanded arena of his cognitive and emotional life has been poured all the concrete "hardware" and techniques of the machine age, together with those novel—and rather more disturbing—abstractions of modern science. As in the case of the adolescent, his psyche is ill-prepared to cope with the rapid blows of expanding reality.

How, then, can Man make sense out of all this? First this section will look at contemporary thought in the social sciences, in short, it will start with the cognitive side of the coin. Second will be the relationships of what we know, to what we feel, to what we believe, i.e., the relationships between fact, theory, and value. As was stated in the General Introduction, no theoretical system will be attempted in the area of either cognition or value, but merely a rough map plus suggestions as to where certain paths lead.

Ever since Adam Smith, there has been a place for the machine in the systematic thinking of economists. And as each of the other social sciences has matured—anthropology, psychology, sociology—the influence of technology on man's social activities and on his psyche has come to be recognized. In Germany what is called "ergonomics" and in the United States "human engineering" has become a branch of applied psychology which specializes in designing machines, tools, and work areas to better fit the physiological and perceptual limitations of human beings. After World War II a series of studies on work fatigue, both mental and physical, was made in the United States and Great Britain which contributed enormously to the elementary knowledge of man-machine relationships. Finally, in the last decade, the "technological component" generally has come to be recognized by all the separate social sciences. They look on it as a basic environmental factor affecting the systems or structures to be studied or as a force to be observed and measured when looking at systems undergoing change. The number of research projects, for example, on the impact of automation sometimes by economists, sometimes by behavioral scientists, has multiplied. (See bibliographies for Part Two for a few outstanding studies.) From the standpoint of organizational theory, March and Simon's *Organizations* is outstanding in its recognition and analysis of technological influences. More and more papers are now being written by economists and behavioral scientists which deal with organizational and technological change. The references given show that economics, sociology, psychology, and organizational theory are giving increasing attention to the component of technology within their separate disciplines.

But what still appears to be lacking, and for which there is an urgent need, is a cognitive pattern (or series of patterns) which will tie together the specialized and often divisive approaches of these separate disciplines. The typical way to express this need is to call for an "interdisciplinary approach." But we need not only collaboration between specialists but basic training and experience in joint research that will make each collaborating specialist to some degree a "generalist." We also need projects of collaboration between specialists in action—administrators—and those who specialize in thinking—the theorists. We should take a leaf from the notebook of the biological sciences—and especially from medicine. Here it is good procedure for a man to combine laboratory research with "practice"; to pursue scientific research but also practice the diagnosis and curing of sick persons. The field of socio-technical interrelationships occurs in ongoing *living organizations;* the field of medicine is within the complex systems of *living organisms.*

The selections at the close of this introduction will illustrate and, to a degree, demonstrate the above points.

The first selection, by Robert Merton, recommends an all-out multidisciplinary approach in which engineers, psychologists, sociologists, and economists would make a large-scale research attack on the most urgent problems which technology poses for modern society. The first point of significance in this paper is the inclusion of engineering in the research enterprise. Most interdisciplinary projects within the social sciences do not include engineering disciplines. And yet, the engineer is increasingly the architect of the house of industry. A majority of the selections in this volume illustrate this point.

There is another reason why collaboration between engineers and social scientists is important and may give us the tools we need for both thinking and doing. Engineering professions generally have *already* collected and systematized an immense amount of pertinent data, a substantial segment of which bears directly on relationships between men and machines. To be sure, as Merton points out, the engineer has codified his information for a limited purpose, and often with limited assumptions. Nevertheless, he is today the principle professional practitioner in the field of socio-technical relations. It is the author's contention and the argument of this book that the engineer badly needs the social scientist. But the author also contends that the social scientist badly needs the engineer if he is to look intelligently at the machine-man complex.

The first selection recommends what might be done. The next two illustrate what has already been achieved by a few teams of theorists and practitioners in thinking and in doing something about technology and organization.

Both selections develop a special way of theorizing about the relation of technology to social structure, and both are based on years of carefully documented research in the British coal industry by the Tavistock Institute, a nongovernmental research center in England. The papers have a certain medical flavor which is not surprising since one impulse toward starting this research came from evidence of serious "stress illness" among

British coal miners. The type of broad interdisciplinary approach practiced by the Institute reminds one of Professor Merton's recommendations. To begin with, the research teams were obliged to become thoroughly knowledgeable in certain principles of mining engineering; second, the analysis of social structure called for the skills of the sociologist; third, the professional approach of the psychologist was needed to diagnose and measure the impact of *alternative social structures* on the stress levels of groups and individuals; fourth, the effects were statistically measured in economic terms.

The first paper, entitled "Social Structure and Psychological Stress," although written mainly for an audience interested in mental health, is an excellent brief introduction to Tavistock's "socio-technical" way of thinking. The second paper, "Socio-technical Systems," puts the same approach into theoretical perspective. It demands of the reader some sophistication in social science literature and shows how the technological component, stressed throughout this book, may be integrated into one of the main streams of conceptualization about social structure. The same empirical data derived from the coal mining industry are again cited, but in a new context.

It is unfortunate that another substantial job of research sponsored by Tavistock and exhibiting the same socio-technical approach, *Productivity and Social Organization: The Ahmedabad Experiment,* is not suitable for condensation. The experiment, which was performed in Ahmedabad, India, in a modern textile mill, verifies the usefulness of the research approach applied in England. As in the coal research, two alternative social structures were studied *without altering the technology.* An interesting difference between the Indian textile mill research and that undertaken in the British mines was that the second social system in India was deliberately devised on the basis of a social diagnosis and experimentally introduced. But in England, for the most part, the more successful social structure emerged spontaneously from suggestions made by the miners. In both cases efficiency, quality, and individual satisfaction were markedly increased. The Indian experiment is fully described and meticulously documented in the volume by A. K. Rice entitled *Productivity and Social Organization: The Ahmedabad Experiment,* published by Tavistock in 1958. This monograph has special value for the reader interested in the problems of technology in non-Western countries since the new social system which was introduced fitted especially well into the cultural predispositions of the native Indian population.

The next selection, by Alain Touraine, brings another approach to thinking about socio-technicial relationships. The selection is from a book in which the author reports on a substantial piece of research carried out by himself in the Renault automobile factory in Paris. From this research—and from that of other social scientists—Touraine builds a theory for the study of work under modern technological conditions. The theory combines the approaches of the sociologist, the psychologist, and the historian, but with a strong emphasis upon the last. In the course of this paper the author criticizes sharply and usefully certain tendencies in American social science research.

Touraine is one of several social scientists in France who have focused, perhaps more systematically than any other group in Europe, on the impact of modern technologies on society. They all owe much to the pioneer work in this field by Georges Friedmann, former professor at the Sorbonne, and at present director of studies at the École Pratique des Hautes Études.

The French journal *Sociologie du travail* is useful for following the work of this group and, indeed, provides a useful review of comparable work in both Europe and America. As suggested by the title of this journal, Friedmann and many, though not all, of his colleagues focus their studies upon "work" in the modern world, but work interpreted very broadly to include, for example, much of what Americans would consider as rightfully belonging to organizational theory.

Professor Friedmann has published many books which are relevant to the themes of this section. A brief summary of the conclusions of one of them, *Le Travail en miettes,* (published in English as *The Anatomy of Work*) is given immediately below. "En miettes" means, literally, "bits and pieces," and the basic theme of the book is the "fracturing" of work under the impact of modern technology. This, as the reader will remember, was one of the subjects of our section Mass Production and Scientific Management. But Professor Friedmann, in "The Anatomy of Work," puts his theme into a far wider perspective. He suggests that the changed character of much of modern work is a threat to the health and balance of the human personality and to the civilization in which we live.

Friedmann says that "powerful currents tend to weaken the role of work in the life of the individual." Two such currents are the tendency of mass-production methods to further fractionalize labor and the tendency of automation to impersonalize labor. He grants that "on certain frontiers" automation is a counterforce to the fracturing process. "But both, on the whole," he concludes, "reduce the number of those professional tasks which used to carry with them *an engagement* of the personality and so had a beneficial effect."

Is the increase of leisure, together with the cultural and recreational activities outside of work, the answer to the "degradation of work" in the modern world? Friedmann is inclined to doubt this, though he suggests that here is an important "domain for observation which should attract sociologists and psychologists."

He is careful not to include all modern work in his indictment. "There still remain," he notes, "in agriculture, industry, commerce and in the whole area of tertiary services a great many functions where the personality can engage itself in various ways." But he ends his analysis of fractured or overspecialized tasks brought about by modern technology with a plea for action by administrators, by industry, by government, by technicians, and by labor leaders in transforming overspecialized and trivialized labor into something that will make richer and healthier personalities. Most of the practical suggestions for doing so are similar to those we have cited and analyzed in earlier sections. But Friedmann's own emphasis, in this and in his other books, is on developing ties between a man's work and the community in which he works and lives. This is also one of the points which appear in Touraine's selection.

The next selection, "Work and Leisure under Industrialism," by an American writer, Clement Greenberg, approaches the same theme from a somewhat different point of view. The thoughts of both writers clearly push this discussion from the area of social theory and research into the area of human values. Greenberg, who is troubled like Friedmann by what industrialism and technology have done to work, concludes with this admonition:[1] "If man is to continue discovering and realizing his possibilities in history, he will, at this point, have to broach the problem of *culture* and *work*—which is to say, of his *mastery over work*. . . ." [Italics added.] But this is clearly a problem of *value*, and to this subject we now turn.

Social philosophers, commenting on the theme of technology and civilization, are inclined to say: This is a matter not for science, but for morals. We are dealing, basically, not with cognitive questions, but with spiritual ones. To the author the philosophers appear to be right—but only half right. As Lewis Mumford pointed out in Part One, "No matter how completely technics relies on the objective procedures of the sciences, it does not form an independent system, like the universe. . . . The machine itself makes no demands and holds out no promises: it is the human spirit which makes demands and keeps promises. . . ." But the spiritual part of man cannot make viable demands or keep promises unless the thinking part of man knows quite rigorously the principles of action in a real and complicated world. And it is hard to think of a more complicated area of forces and counterforces in this modern world than the tangled forest of socio-technical relationships. Any human spirit, however courageous, who enters without a map and compass may take the wrong turning and lead his companions to disaster. Or, to take another metaphor more sharply apposite: The surgeon with admirable spirit and good will but without adequate skill must not be permitted to take human lives into his hands. No, we need rigorous research and the growth of the scientific point of view in the area of men and machines, and we need it badly. Nevertheless, the philosopher is right that, in the final analysis, we cannot escape questions of value for the individual, for society, or for civilization.

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[1] In reading this selection, the reader should not fail to look at the footnotes. The author has put some of his best thinking into them.

Significantly, this has begun to be recognized by thoughtful persons. In a relatively short-run perspective, leaders of church, state, management, and labor are already asking a sheaf of short-run value questions in the area of technology's impact on society. Some of the most provocative are: How can we guarantee that a new invention will lead to more health, prosperity, or happiness rather than to less of all three? Are all technological developments "good," or are some of them "bad"? Can we prevent technological revolutions from creating pockets of unemployment and poverty? How can we prevent the exploitation of new machines by "selfish interests," and, on the other hand, encourage the use of machines to abolish destitution and to create a "good society"? Briefly, since technology clearly may mean either good or evil for society, how can we *control* it? *Or should we try?*

Social control of technology then, in one form or another, is, I suggest, one important short-run value question already before us. Fortunately, we have an excellent selection given over to an airing of this question. It is a panel discussion by an articulate group of thinkers and doers sponsored by the Center for the Study of Democratic Institutions. The selection is so comprehensive and self-explanatory that it calls, I believe, for only one comment: The participants expressed two sharply opposite views on the question, and the reader may wish to adopt one or the other as his own. Or, perhaps, he may work out a third view—a more "integrative" resolution of the problem presented!

The first viewpoint is that "in terms of technology over-all, it would be absolutely impossible to do anything about it. Let us grant it does some horrible things to society. It also does some wonderful things. . . . This thing (technology) was unleashed on the world. It is going to keep on growing. . . ."

The second viewpoint is that "the whole proposition for appraisal and *control of technology* is built on the [last speaker's] statement that technology is the pervasive fact of our lives. I prefer to think that we should remain in control of our own lives, and that technology should not take over."

We began this book by trying to put its theme and subject matter into the perspectives of time, space, and history. We conclude by reemphasizing these perspectives and expanding some of their dimensions. A remarkable group of distinguished biologists believe that Man now stands at a crossroads in the long evolutionary process which has brought him dominance over all other animals and control of the nonliving resources of the planet. It is a commonplace for social philosophers to add that now Man has to learn mastery over himself. Biologists put the matter more precisely by defining Man's problems and opportunities in terms of a well-documented *evolutionary* process. This relates Man both to his actual past and to his probable, or at least possible, future. To greatly oversimplify their appraisal of the matter: Both human evolution and the evolution of the planet Earth are no longer quantitative, but are better described as qualitative. For our purposes and within the limits of the foreseeable future, the most important evolutionary developments will not reside in instinctual areas, such as in the bodily organisms of men and animals, or in the inorganic matter on the planet, though they will continue in both areas. Development now originates in man's *consciousness* and in his conscience. If this generalization by the biologists, with its implicit commentary on the future of man and of civilization, is correct, then the role of science and technology is surely strategic. This "approach" is also, I believe, the biologists' way of saying: We can no longer leave to chance or to self-centered groups the future development of human knowledge and its crucial applications. As a corollary: Knowledge and value, in the most basic and broad senses, are not separable. Or put another way: The development—especially the future development—of science and technology is closely interrelated with the development of man's *other* major activities, his philosophy, his aesthetic achievements, and his spiritual beliefs.

At this point, the reader is advised to leave the author's inadequate summaries and comments on these matters and turn to the final selection. Julian Huxley writes

> The new vision we owe to science is one of real though tempered optimism. It gives us a measure of significance [a value word] and rational hope [a cognitive phrase] in a world which appeared irrational and meaningless. It shows us man's place and role in the universe. He is the earth's reservoir of evolutionary possibility; the *servant of evolution, but at the same time its youthful master.* [Italics added.]

Like Huxley, the author is contented to end this inquiry into modern technology and civilization with "real though tempered optimism."

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I. THE MACHINE, THE WORKER, AND THE ENGINEER

From R. K. Merton, *Social Theory and Social Structure*, Free Press, Glencoe, Ill., 1957, pp. 567–573.

IMPLICATIONS FOR THE ENGINEER

New applications of science to production by the engineer . . . do not merely affect the methods of production. They are inescapably social decisions affecting the routines and satisfactions of men at work on the machine and, in their larger reaches, shaping the very organization of the economy and society.

The central role of engineers as the General Staff of our productive systems only underscores the great importance of their social and political orientations: the social strata with which they identify themselves; the texture of group loyalties woven by their economic position and their occupational careers; the groups to whom they look for direction; the types of social effects of their work which they take into account—in short, only by exploring the entire range of their allegiances, perspectives, and concerns can engineers achieve that self-clarification of their social role which makes for fully responsible participation in society.

But to say that this poses sociological problems for "the" engineer is to make a reference so inclusive and vague as to mean little at all. The large and multifarious family of men called engineers have a far-flung kinship, but they also have much that marks subgroups off, each from the others. There are military, civil, mechanical, chemical, electrical, and metallurgical engineers, and so on down through the hundreds of titles found among the members of national engineering societies. But whatever their specialty, so long as they are concerned with the design, construction, or operation of the equipments and processes of production, they are confronted with social and political implications of their position in our society.

A nascent trend toward full recognition of these implications is curbed by several obstacles, chief among which, it would seem, are (1) the marked specialization and division of scientific labor, (2) the applications of professional codes governing the social outlook of engineers, and (3) the incorporation of engineers into industrial bureaucracies.

Specialization

The intensified division of labor has become a splendid device for escaping social responsibilities. As professions subdivide, each group of specialists finds it increasingly possible to "pass the buck" for the social consequences of their work, on the assumption, it would seem, that in this complex transfer of responsibility there will be no hindmost for the devil to take. When appalled by resulting social dislocations, each specialist, secure in the knowledge that he has performed his task to the best of his ability, can readily disclaim responsibility for them. And, of course, no one group of specialists, the engineer any more than the others, alone initiates these consequences. Rather, within our economic and social structure each technological contribution meshes into a cumulative pattern of effects, some of which none has desired and all have brought about.

The Professional Ethic

Deriving in part from the specialization of functions, engineers, not unlike scientists, come to be indoctrinated with an ethical sense of limited responsibilities. The scientist, busy on his distinctive task of carving out new knowledge from the realm of ignorance, has long disclaimed responsibility for attending to the ways in which this knowledge was applied. (History creates its own symbols. It required an atomic bomb to shake many scientists loose from this tenaciously held doctrine.)

So, in many quarters, it has been held absurd that the engineer should be thought accountable for the social and psychological effects of technology, since it is perfectly clear that these do not come within his special province. After all, it is the engineer's "job"—note how effectively this defines the limits of one's role and, thereby, one's social responsibility—to improve processes of production, and it is "not his concern" to consider their ramified social effects. The occupational code focuses the attention of engineers upon the first links in the chain of consequences of technological innovation and diverts their attention, both as specialists and as citizens, from succeeding links in the chain as, for example, the consequences for wage levels and employment opportunities. "But we have to include consequences impartially"—this is John Dewey putting the issue in more general form. "It is willful folly to fasten upon some single end or consequence which is liked, and permit the view of that to blot from perception all other undesired and undesirable consequences."

Bureaucratic Status

The employment of large numbers of engineers and technologists in industrial bureaucracies further shapes their social perspectives. Knit into a bureaucratic apparatus, many engineers take their place as experts in a subaltern role with fixed spheres of competence and authority and with a severely delimited orientation toward the larger social system. In this status, they are rewarded for viewing themselves as technical auxiliaries. As such, it is not their function to consider the human and social consequences of introducing their efficient equipments and processes or to decide when and how they are to be introduced. These are matters for administrative and managerial concern.

The grounds for assigning these concerns to administrators in business and industrial organizations have seldom been stated as lucidly and instructively as in the following passage by Roethlisberger: ". . . physicists, chemists, mechanical, civil, chemical engineers have a useful way of thinking about and a simple method of dealing with their own class of phenomena. Within this area their judgments are likely to be sound. Outside it their judgments are more questionable. Some of them recognize quite clearly this limitation. They do not want to be concerned with the human factor; they want to design the best tool, the best machine to accomplish certain technical purposes. Whether or not the introduction of this tool or machine will involve the layoff of certain employees, quite rightly, is not their concern as engineers. . . . These men are invaluable to the administrator in any industrial organization."

Max Weber and Thorstein Veblen, among others, have pointed to the danger that this occupational perspective, involving the rationalized abdication of social responsibility in favor of the administrator, may be transferred by engineers beyond the immediate economic enterprise. From this transference of outlook and the resulting trained incapacity for dealing with human affairs there develops a passive and dependent role for engineers and technologists in the realm of political organization, economic institutions, and social policy. The citizen-self threatens to become submerged in the occupational self.

As technical specialists thus attend to "their own" limited tasks, the over-all impact of technology upon the social structure becomes nobody's business through default.

THE NEEDS OF SOCIAL RESEARCH

Engineers may well continue to abjure any direct concern with the social effects of an advancing technology as long as the effects cannot be anticipated and taken into account. To the extent that social scientists have failed to address themselves to this problem, there is no informed basis for the most socially oriented of technologists to act with due social responsibility. Only when those equipped with the skills of social research make available an adequate body of scientific knowledge can those working with the skills of engineering extend their sights from the individual business enterprise to the larger social system.

Just as men for centuries neglected the problems of soil erosion, in part because they were unaware that erosion constituted a significant problem, so they are still neglecting the social erosion ascribable to present methods of introducing rapid technological changes. There is a severely limited market for research in this field. It seems safe to suppose that fewer man-hours of research activity are devoted to the intensive investigation of these problems central to our technological age than, say to the design of alluring packages for perfumes and other such basic commodities or to the planning of competitive advertisements for the tobacco manufacturers of the nation.

The inauguration of a vast program of social inquiry proportioned to the scale of the problem need not wait upon new research procedures. Methods of social research have been advancing steadily and will undoubtedly become developed further through disciplined experience. The effective development of this program does wait, however, upon decisions concerning the organization of the research teams, sponsorship of the research, and the directions of inquiry.

Organization of the Research Team

Disparate and uncoordinated inquiries by diversely skilled groups have not proved adequate. The problems in this area call for the complementary skills and knowledge of engineers, economists, psychologists, and sociologists. Once this focus of joint inquiry is recognized, systematic efforts to institute a program of collaborative investigation could be begun by representatives of the several professional societies. Common universes of discourse would probably be lacking at the outset, but, as the experience of the TVA suggests, patterns of collaboration between engineers and social scientists can be evolved. The walls insulating the several disciplines raised up by the division of scientific labor can be surmounted if they are recognized for the temporary expedients that they are.

Sponsorship of the Research

Of the limited body of social research in industry, the greater part has been oriented toward the needs of management. The problems selected as the focus of the inquiry—high labor turnover and restricted output, for example—have been largely thus defined by management, sponsorship has been typically by management, the limits and character of experimental changes in the work situation have been passed upon by management, and periodic reports have been made primarily to management. No matter how good or seemingly self-evident the reason, it should be noted that this *is* the typical perspective of social research in industry and that it limits the effective prosecution of the research.

These remarks do not, of course, impugn the validity and usefulness of research oriented toward the needs of management. From the fact that this research continues to be sponsored by management, we can conclude only that it has been found eminently useful and valid, within the limits of the definition of problems. But an intelligence staff for one stratum of the business and industrial population may in due course find itself focusing on problems which are not the chief problems confronting other sectors of that population. It may happen, for example, that devising methods of reducing workers' anxieties through sympathetic and prolonged interviews or through appropriate behavior by supervisors is not among those researches which workers regard as central to their interests. They may be more concerned with having research men uncover the varied consequences, for themselves and for others, of alternative plans governing the introduction of technological changes.

This reminds us that social research itself takes place within a social setting. The social scientist who fails to recognize that his techniques of participant-observation, interviewing, sociogramming, and the like represent an innovation for workers and supervisors greater, perhaps, than technological changes in the plant would indeed be a dubious believer in his own findings. Resistance to this innovation can be anticipated, if only because it is remote from run-of-the-mill experience of most people. Those who have engaged in social research among workers and administrative personnel need not be told of the mingled suspicion, distrust, uneasy amusement, and, often, open hostility with which they were initially met. Unfamiliarity with this type of inquiry, coupled with its apparent inquisitiveness into areas of tension and private affairs, makes for some measure of resistance.

If the research is subsidized by management and if the problems dealt with are relevant primarily to management, the resistance of workers will be all the greater. It is small wonder that in some quarters of organized labor the preliminary efforts at social research in industry are regarded with a measure of suspicion and distrust comparable to that which attended the introduction of scientific management studies in the 1920's. For if workers have occasion to identify the research program as a newfangled academic device for countering labor organizations or for scientifically substituting symbolic for material rewards, it will create rather than locate problems.

Social research in industry, therefore, must be conducted under the joint auspices of management and labor, irrespective of the source of funds for the research. The cooperation of large numbers of workers will not be achieved unless they know that they will be beneficiaries of an application of scientific method to a field where rule-of-thumb has largely prevailed.

The Directions of Research

The initial task of these research teams would be to search out the specific problems which demand attention. The very fact that they undertake the research would indicate that they are not possessed by the opaque faith that forward strides in technology, howsoever applied, must lead to the common good. They would be expected to think dangerous thoughts. They would not hold cultural and institutional axioms to be beyond inquiry. The focus of their attention would be the institutional arrangements adequate to incorporate the full potentialities for production of an unevenly but continuously advancing technology with an equitable distribution of gains and losses contained in these advances.

During the last decade there has occurred a reaction among social researchers against the earlier tendency to focus on the economic consequences of advances in technology. The center of research attention was shifted to workers' sentiments and social relations on the job. This new emphasis, however, has the defects of its qualities. It is not only the sentiments of workers which are affected by technological change. It is not only their social ties and their status—it is also their incomes, their job chances, and their economic interests. If the new research on human relations in industry is to have maximum pertinence, it must be meshed with the continuing research on the economic implications of labor-saving technology.

Nor can the research be effectively confined to studies of "the worker." To single out the worker as though he represented a self-contained sector of the industrial population is to do violence to the structure of social relations which actually obtains in industry. Presumably, it is not only the worker who is subject to preoccupations, obsessive reveries, defects and distortions of attitude, and irrational dislikes of co-workers or supervisors. It might even turn out that the behavior and decisions of management are appreciably affected by similar psychological patterns and that these, as well as a clear-cut sense of economic interests, go far toward determining decisions on the introduction of labor-saving technology.

In the absence of research jointly sponsored by labor and management and aimed at commonly agreed-upon problems of the role of technology in our society, the alternative is to pursue the present pattern of piecemeal research, directed toward those special problems which it is in the interest of special groups to have examined. It is possible, of course, that this alternative will seem preferable to some. It is altogether possible that the several interested groups will find no basis for agreement on the sponsorship and direction of social research in this field. But then, this too would serve its backhanded purpose. Should research by technologists and social scientists under the joint auspices of management and labor be rejected on these grounds, it would be a significant diagnostic sign of the state which industrial relations have reached.

2. SOCIAL STRUCTURE AND PSYCHOLOGICAL STRESS

From E. L. Trist, "Work Organization at the Coal Face," Mental Health Research Fund Conference on Research on Stress in Relation to Mental Health and Mental Illness, Lincoln College, Oxford, July 15–18, 1958.

Especially since the early years of the late war, a body of knowledge has been coming into existence which is enabling us better to understand the effects of stress at social level. We are becoming able to choose more surely between alternative forms of social organization so that at one and the same time the psychological health of the individual may be benefited and the standard of his performance improved.

Let me illustrate from studies carried out by the Tavistock Institute in the mining industry (5). Work at the coal face is by common consent among the most stressful of industrial occupations. Any changes in group organization which succeed in reducing this stress, with concomitant gains in productivity, are of great practical interest to those in the industry, whether on the management or the union side. They are also, as I shall hope to show, of theoretical interest to the student of human behaviour.

The problem first came across our horizon as social psychologists through medical channels and through observations originally made by doctors on the subject of stress. Before the last war, Halliday (2) working in Scotland, presented evidence that the incidence of stress illness among miners working at the coal face was something like 2½ times greater than that found among any other occupational group in the insured population in Scotland. There was also a hint in a paper by the late Dr. D. E. Dickson, (1) a colliery medical officer, that this result was not just to be put down to industrial conflict and economic depression. Certainly it has not been affected as much as was anticipated by nationalization or subsequent greater prosperity. It is rather to be related to the change-over from traditional board and pillar working to longwall conveyor mining.[1] Dickson did not follow up his own suggestion in this regard. Indeed, he rather went back on it, but it provided the hint from which our own work has developed. We now think we have identified some of the main stress-producing factors in conventional longwall conveyor organization (4).

We also believe that there is a remedy to this state of affairs in an alternative form of group organization which bears exactly the same technology (6). At the moment, this new form of work organization is arising spontaneously in certain pits and in our recent research programme we have been able to study continuously the first coal faces which have fully developed this new organization from the moment of their origin right through to the end of their face life, a period of twenty months (3).

In traditional board and pillar working, living examples of which are still to be found in the older coal fields, the total work cycle that comprises the coal getting task is carried out by one small group of people which is within face-to-face limits as regards size. Usually, this group was no more than six people spread over three shifts. They were one social group, with one pay slip. They were self-selected and all regarded each other as mates. They carried out the entire range of tasks sharing the more inconvenient with the more convenient shifts. This was the traditional group which had a quality which elsewhere I have called responsible autonomy (4). Such a group manages itself in the underground situation and adapts itself flexibly to the changing and unpredictable character of that situation. This form of group is highly adaptive to the realities of the underground situation. It has been evolved through generations of experience in this particular type of dangerous environment. We are dealing here with an end product which is a highly sophisticated social structure. In it the miner may have had to work hard, but however much he was discontented with managers and owners he was not psychologically stressed as he has become in conventional longwall work groups.

What happened to that traditional organization when the technical change took place? There is now a much larger total cycle group—41 men in the faces included in our recent study and more than twice as many in very long faces in high seams. These 41 men have been split into 14 separate task groups with different goals and different pay notes. There are five such task groups on the first shift, three on the second, six on the third. The traditional unitary face group has been atomized into a large number of segregated single task groups according to the prevailing ideology of work breakdown which characterizes attitudes and thinking in production engineering. But no overall social organization has been brought into being which unites these different sub-groups into a total group with the overall goal of cycle completion. Yet from the point of view of the technical system cycle completion remains an indivisible primary task. Because the overall cycle group is only an aggregate it has no mechanisms for internal self-regulation. Regulation must be supplied entirely from the outside—by face and seam management. In the underground situation this is possible only to a limited extent while the component groups to varying degrees compete, conflict or collude with each other so that cycle progress tends to be impaired. Tension tends therefore to be a persistent feature of relationships both between management and workers and among the various working groups themselves.

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[1] This was a strictly technological factor, and one belonging to the general category of increased mechanization. C. R. W.

What happens in the emergent system to remedy this situation? An overall organization has been created which welds the various single task groups into a unified social whole concerned with cycle completion as a group goal. Members share a common pay note and exchange tasks and shifts according to principles they have evolved for themselves; the relationship of "mate" extends to all members of the cycle group. The quality of responsible autonomy is restored. The cycle group has once again become internally self-regulating. This changes the relations of all component groups throughout the system and between the cycle group and face and seam management. It is a system change.

In Tables 1–3 are the results from two coal faces, one organized on conventional lines with 41 men in 14 different groups; another using exactly the same technology and equipment, exactly the same seam of coal, but organized on the new principle called composite.

In Table 1 you can see how the conventional organization restricts a man to one task which is worked on alternating shifts with one little work group; it is absolutely rigid like that. In the composite work method, he varies his work task, he varies his shift, he varies the task groups with which he works; there is much greater flexibility throughout.

We may take withdrawal from the work situation[2] (represented by absenteeism from all causes)—when the person temporarily gives up his work role for one reason or another and is not there—as a measure of sociological casualty. The environments of the two faces were about as similar as they could be, but the difference in absenteeism is indicated by the figures in Table 2. This is an objective indicator of stress reduction on the composite face and of the extent of its absorption by a different type of social structure.

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[2] Hill, J. M. M., and Trist, E. L., "A Consideration of Industrial Accidents as a Means of Withdrawal from the Work Situation," Hum. Relat., Vol. VI, No. 4, 1953.
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TABLE 1. VARIETY OF WORK EXPERIENCE
(Averages for whole team)

Aspect of work experience	Conventional longwall	Composite longwall
Main tasks worked at	1.0	3.6
Different *shifts* worked on	2.0	2.9
Groups worked with	1.0	5.5

TABLE 2. ABSENCE RATES
(Per cent of possible shifts)

Reason for absence	Conventional longwall	Composite longwall
No reason given	4.3	0.4
Sickness and other	8.9	4.6
Accident	6.8	3.2
Total	20.0	8.2

TABLE 3. PRODUCTIVITY AS PER CENT OF ESTIMATED FACE POTENTIAL

Conventional longwall	Composite longwall
78	95

When we wanted to make the comparison in terms of the performance of the primary task, we had great difficulty in finding measures which were applicable. We were able, however, to devise a method by which we could make a quite accurate estimate of the potential productivity of a particular coal face. We could then see how far a team was functioning below that. The level of function of the two systems in comparable faces in the same seam with exactly the same sort of men is given in Table 3. It will be apparent that the less stressful system is operating much closer to the limit of its potentiality. It is also the more productive.

DR. JOHN I. LACEY: Do you have some evidence from interviews with the miners themselves as to what the impact of the social change is on them? What do they say about it?

MR. E. TRIST: We have conducted interviews and group discussions with the men in three different coal fields. The results have been the same in each case. The new system has emerged from the men as much as from the management. It comes out of their pit experience, and is very strongly backed by the local union. The men express quiet enthusiasm.

They feel released once they experience working in the new relationship. When you catch them in the process of change they are pretty articulate too; they leave you in no doubt whatever. The older ones of them compare their experience of working in the old board and pillar system. They feel they have recovered something lost and begin to recognize that composite working is the natural inheritor of the older tradition under longwall conditions. Composite faces do not always go well. But where they have failed or regressed we have evidence that their principles and meaning were not fully understood or accepted by those concerned.

What is of particular interest to the social psychologist is that such a large primary work group should be capable of such a high degree of self-regulation. It is this responsible autonomy which seems to occasion the psychological engagement of the worker, to overcome his "alienation," so reducing his frustration—and therefore his stress even under difficult conditions. It is not commonly accepted that this state of affairs is possible in such large groups. Here our findings break new ground.

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3. SOCIO-TECHNICAL SYSTEMS

From F. E. Emery and E. L. Trist, "Socio-technical Systems," 6th Annual International Meeting of the Institute of Management Sciences, Preprint no. 3, Pergamon Press, Inc., New York, 1959.

The analysis of the characteristics of enterprises as systems would appear to have strategic significance for furthering our understanding of a great number of specific industrial problems. The more we know about these systems the more we are able to identify what is relevant to a particular problem and to detect problems that tend to be missed by the conventional framework of problem analysis.

The value of studying enterprises as systems has been demonstrated in the empirical studies of Blau (4), Gouldner (6), Jaques (8), Selznick (15) and Lloyd Warner (21). Many of these studies have been informed by a broadly conceived concept of bureaucracy, derived from Weber and influenced by Parsons and Merton (6):

> They have found their main business to be in the analysis of a specific bureaucracy as a complex social system, concerned less with the individual differences of the actors than with the situationally shaped roles they perform.

Granted the importance of system analysis there remains the important question of whether an enterprise should be construed as a "closed" or an "open system," i.e. relatively "closed" or "open" with respect to its external environment. Von Bertalanffy (3) first introduced this general distinction in contrasting biological and physical phenomena. In the realm of social theory, however, there has been something of a tendency to continue thinking in terms of a "closed" system, that is, to regard the enterprise as sufficiently independent to allow most of its problems to be analysed with reference to its internal structure and without reference to its external environment. Early exceptions were Rice and Trist (11) in the field of labour turnover and Herbst (7) in the analysis of social flow systems. As a first step, closed system thinking has been fruitful, in psychology and industrial sociology, in directing attention to the existence of structural similarities, relational determination and subordination of part to whole. However, it has tended to be misleading on problems of growth and the conditions for maintaining a "steady state." The formal physical models of "closed systems" postulate that, as in the second law of thermodynamics, the inherent tendency of such systems is to grow toward maximum homogeneity of the parts and that a steady state can only be achieved by the cessation of all activity. In practice the system theorists in social science (and these include such key anthropologists as Radcliffe-Brown) refused to recognize these implications but instead, by the same token, did "*tend* to focus on the statics of social structure and to neglect the study of structural change" (10). In an attempt to overcome this bias, Merton suggested that "the concept of dysfunction, which implies the concept of strain, stress and tension on the structural level, provides an analytical approach to the study of dynamics and change" (10). This concept has been widely accepted by system theorists but while it draws attention to sources of imbalance within an organization it does not conceptually reflect the mutual permeation of an organization and its environment that is the cause of such imbalance. It still retains the limiting perspectives of "closed system" theorizing. In the administrative field the same limitations may be seen in the otherwise invaluable contributions of Barnard (2) and related writers.

The alternative conception of "open systems" carries the logical implications that such systems may spontaneously re-organize toward states of greater heterogeneity and complexity and that they achieve a "steady state" at a level where they can still do work. Enterprises appear to possess at least these characteristics of "open systems." They grow by processes of internal elaboration (7) and manage to achieve a steady state while doing work, i.e. achieve a quasi-stationary equilibrium in which the enterprise as a whole remains constant, with a continuous "throughput," despite a considerable range of external changes (9, 11).

The appropriateness of the concept of "open system" can be settled, however, only by examining in some detail what is involved in an enterprise achieving a steady state. The continued existence of any enterprise presupposes some regular commerce in products or services with other enterprises, institutions and persons in its external social environment. If it is going to be useful to speak of steady states in an enterprise, they must be states in which this commerce is going on. The conditions for regularizing this commerce lie both within and without the enterprise. On the one hand this presupposes that an enterprise has at its immediate disposal the necessary material supports for its activities—a workplace, materials, tools and machines—and a work force able and willing to make the necessary modifications in the material "throughput" or provide the requisite services. It must also be able, efficiently, to utilize its material supports and to organize the actions of its human agents in a rational and predictable manner. On the other hand, the regularity of commerce with the environment may be influenced by a broad range of independent external changes affecting markets for products and inputs of labour, materials and technology. If we examine the factors influencing the ability of an enterprise to maintain a steady state in the face of these broader environmental influences we find that:

a. The variation in the output markets that can be tolerated without structural change is a function of the flexibility of the technical productive apparatus—its ability to vary its rate, its end product or the mixture of its products. Variation in the output markets may itself be considerably reduced by the display of distinctive competence. Thus the output markets will be more attached to a given enterprise if it has, relative to other producers, a distinctive competence—a distinctive ability to deliver the right product to the right place at the right time.

b. The tolerable variation in the "input" markets is likewise dependent upon the technological component. Thus some enterprises are enabled by their particular technical organization to tolerate considerable variation in the type and amount of labour they can recruit. Others can tolerate little.

The two significant features of this state of affairs are [that]:

i. There is no simple one-to-one relation between variations in inputs and outputs. Depending upon the technological system, different combinations of inputs may be handled to yield similar outputs and different "product mixes" may be produced from similar inputs. As far as possible an enterprise will tend to do these things rather than make structural changes in its organization. It is one of the additional characteristics of "open systems" that while they are in constant commerce with the environment they are selective and, within limits, self-regulating.

ii. The technological component, in converting inputs into outputs, plays a major role in determining the self-regulating properties of an enterprise. It functions as one of the major boundary conditions of the social system of the enterprise in thus mediating between the ends of an enterprise and the external environment. Because of this the materials, machines and territory that go to making up the technological component are usually defined, in any modern society, as "belonging" to an enterprise and excluded from similar control by other enterprises. They represent, as it were, an "internalized environment."

Thus the mediating boundary conditions must be represented amongst "the open system constants" (3) that define the conditions under which a steady state can be achieved. The technological component has been found to play a key mediating role and hence it follows that the open system concept must be referred to the socio-technical system, not simply to the social system of an enterprise.

It might be justifiable to exclude the technological component from the system concept if it were true, as many writers imply, that it plays only a passive and intermittent role. However, it cannot be dismissed as simply a set of limits that exert an influence at the initial stage of building an enterprise and only at such subsequent times as these limits are overstepped. There is, on the contrary, an almost constant accommodation of stresses arising from changes in the external environment; the technological component not only sets limits upon what can be done, but also in the process of accommodation creates demands that must be reflected in the internal organization and ends of an enterprise.

Study of a productive system therefore requires detailed attention to both the technological and the social components. It is not possible to understand these systems in terms of some arbitrarily selected single aspect of the technology such as the repetitive nature of the work, the coerciveness of the assembly conveyor or the piecemeal nature of the task. However, this is what is usually attempted by students of the enterprise (5). In fact:

> It has been fashionable of late, particularly in the "human relations" school, to assume that the actual job, its technology, and its mechanical

> and physical requirements are relatively unimportant compared to the social and psychological situation of men at work.

Even when there has been a detailed study of the technology this has not been systematically related to the social system but been treated as background information (21).

In our earliest study of production systems in coal mining (19) it became apparent that

> So close is the relationship between the various aspects that the social and the psychological can be understood only in terms of the detailed engineering facts and of the way the technological system as a whole behaves in the environment of the underground situation.

An analysis of a technological system in these terms can produce a systematic picture of the tasks and task interrelations required by a technological system. However, between these requirements and the social system there is not a strictly determined one-to-one relation but what is logically referred to as a correlative relation.

In a very simple operation such as manually moving and stacking railway sleepers ("ties") there may well be only a single suitable work relationship structure, namely, a co-operating pair with each man taking an end of the sleeper and lifting, supporting, walking and throwing in close co-ordination with the other man. The ordinary production process is much more complex and there it is unusual to find that only one particular work relationship structure can be fitted to these tasks.

This element of choice and the mutual influence of technology and the social system may both be illustrated from our studies, made over several years, of work organization in British deep seam coal mining. The following data are adapted from Trist and Murray. (20)

Thus Table 1 indicates the main features of two very different forms of organization that have both been operated economically within the same seam and with identical technology.

TABLE 1. SAME TECHNOLOGY, SAME COALSEAM, DIFFERENT SOCIAL SYSTEMS

	A conventional cutting longwall mining system	A composite cutting longwall mining system
Number of men	41	41
No. of completely segregated task groups	14	1
Mean job variation for members:		
task groups worked with	1.0	5.5
main tasks worked	1.0	3.6
different shifts worked	2.0	2.9

The conventional system combines a complex formal structure with simple work roles: the composite system combines a simple formal structure with complex work roles. In the former the miner has a commitment to only a single part task and enters into only a very limited number of unvarying social relations that are sharply divided between those within his particular task group and those who are outside. With those "outside" he shares no sense of belongingness and he recognizes no responsibility to them for the consequences of his actions. In the composite system the miner has a commitment to the whole group task and consequently finds himself drawn into a variety of tasks in co-operation with different members of the total group; he may be drawn into any task on the coal-face with any member of the total group.

That two such contrasting social systems can effectively operate the same technology is clear enough evidence that there exists an element of choice in designing a work organization.

However, it is not a matter of indifference which form of organization is selected. As has already been stated, the technological system sets certain requirements of its social system and the effectiveness of the total production system will depend upon the adequacy with which the social system is able to cope with these requirements. Although alternative social systems may survive in that they are both accepted as "good enough" (17) this does not preclude the possibility that they may differ in effectiveness.

In this case the composite systems consistently showed a superiority over the conventional in terms of production and costs.

TABLE 2. PRODUCTION AND COSTS FOR DIFFERENT FORMS OF WORK ORGANIZATION WITH SAME TECHNOLOGY

	"Conventional"	"Composite"
Productive Achievement *	78	95
Ancilliary work at face (hrs. per man-shift)	1.32	0.03
Average reinforcement of labour (per cent of total face force)	6	—
Per cent of shifts with cycle lag	69	5
No. consecutive weeks without losing a cycle	12	65

* Average percent of coal won from each daily cut, corrected for differences in seam transport.

This superiority reflects, in the first instance, the more adequate coping in the composite system with the task requirements. The constantly changing underground conditions require that the already complex sequence of mining tasks undergo frequent changes in the relative magnitudes and even the order of these tasks. These conditions optimally require the internal flexibility possessed in varying degrees by the composite systems. It is difficult to meet variable task requirements with any organization built on a rigid division of labour. The only justification for a rigid division of labour is a technology which demands specialized non-substitute skills and which is, moreover, sufficiently superior, as a technology, to offset the losses due to rigidity. The conventional longwall cutting system has no such technical superiority over the composite to offset its relative rigidity—its characteristic inability to cope with changing conditions other than by increasing the stress placed on its members, sacrificing smooth cycle progress or drawing heavily upon the negligible labour reserves of the pit.

The superiority of the composite system does not rest alone in more adequate coping with the tasks. It also makes better provision to the personal requirements of the miners. Mutually supportive relations between task groups are the exception in the conventional system and the rule in the composite. In consequence, the conventional miner more frequently finds himself without support from his fellows when the strain or size of his task requires it. Crises are more likely to set him against his fellows and hence worsen the situation.

Similarly, the distribution of rewards and statuses in the conventional system reflects the relative bargaining power of different roles and task groups as much as any true differences in skill and effort. Under these conditions of disparity between effort and reward any demands for increased effort are likely to create undue stress.

The following table indicates the difference in stress experienced by miners in the two systems.

TABLE 3. STRESS INDICES FOR DIFFERENT SOCIAL SYSTEMS

Absenteeism (Percent of possible shifts)	"Conventional"	"Composite"
Without reason	4.3	0.4
Sickness or other	8.9	4.6
Accidents	6.8	3.2
Total	20.0	8.2

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4. AN HISTORICAL THEORY IN THE EVOLUTION OF INDUSTRIAL SKILLS

From Alain Touraine, *"L'Évolution du travail ouvrier aux usines Renault,"* Centre national de la recherche scientifique, Paris, 1955.

I. *The Evolution of Skills: Stages and Direction.*

The most obvious fact in the evolution of skills is their massive downgrading in the factory. The worker specializing in a few repetitive and highly simplified jobs[1] replaces the craftsman wherever mass production[2] is installed. But does this important fact make intelligible the whole evolution of skills? Must we agree then with those who believe this development is a catastrophe and who see in the industrial history of the last half century the progressive disintegration of a time-honored system of work which rested on the quality of skill of the "productive" worker? Assuredly no. We are not witnessing an organized system falling into chaos, but the transition from one system to another.

This concept of a transition repudiates optimistic theses as vigorously as pessimistic ones. And even more readily. It is false to assume that the growing complexity of machines is reflected in the skills of workers who operate them; a hasty visit, for example, to modern shops filled with transfer machines will supply convincing evidence on this point. The most refined form of the optimistic thesis, as defended by Ford and by admirers of the new methods of work, cannot stand up before an elementary examination of the facts.

The common mistake of both trends of opinion, optimistic and pessimistic, is to consider the evolution of skills solely from the point of view of quantity, and to assume that the nature of the skill had not been modified. Representatives of both trends discuss the question whether there is more or less—or whether there *will be* more or less—skill required today or tomorrow than there was yesterday. But the most important fact is transformation in the worker's skill. The pessimism of certain observers derives perhaps from this fact that in the most modern factories they do not find the traditional types of skills. Such skills are often mythical in industry, and the observer is transferring to industry certain characteristics of the pre-industrial craftsmen.

This transformation in kind, or transition from one system to another, is not a continuous process; it does not proceed in a straight line, but by a series of contradictions. The old system of work, arranged around a task to be performed directly by the worker is not immediately changed into a system of indirect labor. This latter system begins to take form *only* after the jobs are broken down into their component parts. This notion of two systems of work, then, gives rise to the concept of three phases in the evolution of skills.

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[1] The term used by M. Touraine is l'ouvrier spécialisé, the specialized worker; unfortunately this gives in English an impression quite the reverse of the French, implying as it does a worker with specialized skills. Since American usage seems to lack an exact equivalent, we have used in most cases in the pages that follow the term "mass production worker."

[2] Here again there is no single English phrase that takes the place of the French term "en grande série" although in describing modern methods of mass production we speak of "a series of operations." The French "en grande série" has been translated in these pages sometimes "mass production" sometimes "progressive manufacture."

In our technical study of machine tools we separated their development into three phases, A, B, and C,[3] and proposed this as a hypothesis, indispensable to understanding the facts as observed. These facts, almost all of which were relevant to phase B, could not be understood by a simple description of this phase, considered as a historical unity and self-defined. These phases led us to perceive a single process, not divergent and opposing ones, which constituted a new system of work, new insofar as it destroyed the old system and even by the very fact of destructive action. As a general view of industry helps us to put into perspective the framework of our description, so the evolution of techniques and jobs is better understood by beginning at the central phase which is more easily observed in big industry. This phase has no unity of its own, no coherence, and no stability. It is simultaneously destructive and creative, and to the degree that it destroys the old multi-purpose machines and produces single-purpose specialized ones, it prepares for the emergence of the composite machine and evolves toward automation. Even as regards skill the dissolution into its component parts of "productive" work is the necessary precondition to the mechanisation which liberates man from physical labor. This contradictory nature of phase B cannot be considered by itself; it is not the end of the evolutionary process, it is a link.

One cannot derive the idea of a three phase evolution from the analysis of a single factory. For reasons which lie in the nature of the manufacturing process, complete mechanisation comes only with phase C, except in the case of industries with continuous operations, such as oil refineries, gas, and production of electricity by steam or water. Through observations of a single manufacturing plant, therefore, we cannot investigate the concept of the three phases. We need not assume, however, that all branches of industry have followed the pattern of evolution in the same way. One industry has never come through phase A; another with favorable economic and exceptional technical conditions is able to pass from phase A directly to phase C. Many industries lacking sufficient volume and therefore steady production have not yet passed phase B or even phase A. But in all of these cases the proposed concept is valuable, for it allows us to *place* the factory or sector of industry which is being observed.

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[3] By phase A, the author means the old system of work, characterized by skilled work or craftsmanship which required only universal or flexible machines (like lathes), not limited to the production of a single product; phase B is the period of transition, characterized by the development of mechanization, or the feeding of machines by unskilled workmen; phase C is the phase of automation, where direct productive work by human beings is eliminated.

It is not necessary to assign these phases to successive historical epochs, to suggest for example, that for the French economy phase A belongs to the period of 1815 to 1880; phase B to that of 1880 to 1930; and phase C since 1930. Clearly if, in a given epoch and for general reasons, no enterprise can belong to phase C, at a more advanced date in the same national economy even in the same industrial sector—enterprises can coexist which belong to different phases. In the Renault factory today are juxtaposed central electrical installations, or power plants, belonging to phase C, mechanical shops on the borderline between B and C, and a great number of shops in the classic B phase, as well as a certain number relevant to phase A.

One can only add that enterprises reaching a certain stage of evolution tend to impose a certain orientation on enterprises still in an earlier stage, so that it is possible to some degree to characterize each industrial sector, and even each national economy, according to the labels A, B, and C. Thus the automobile industry is essentially in phase B, the production of electrical energy in phase C, the coal mines (in France) in phase A.

But all research concerned with the evolution of skills must study an enterprise, or a group of enterprises, in relation to economic conditions and techniques of production and not in the light of the state of the national economy in the world situation at the moment.

II. *Technical and Social Aspects of Work: The Evolution of Their Relation to Each Other.*

The descriptive scheme used all along in this study would be without great interest if it did not introduce one of the principal problems of industrial sociology: that of the structure of work. By structure of work is meant the reciprocal relationship of its different aspects—technical, occupational, physiological, psychological, economic and also social, in its various meanings.

Among all these relationships, one seems particularly important: that between the technico-skill aspect and the economico-social aspect of industrial work. The rapid development of technology since the first, and above all since the second industrial revolution, as defined by G. Friedmann, places man more and more in an entirely new environment of life and particularly of work. The technical circumstances of civilization seem to impose themselves in all industrial countries as the "facts of civilization," according to the celebrated phrase of M. Mauss, creating over and above differences in the social order (of which no serious observer neglects the importance) a common situation with certain specific problems.

Technical realities, as related to the conditions of economic and social life, depend upon the market, including the labor market, for example, but this dependence gives no answer to the problems. The dependence does explain the rhythm of technical progress, but it does not explain the social significance of modern production techniques or their role in social life, and especially their role as a factor in the behavior of the industrial work force![4]

Study of the evolution of vocational skills and of the passage from one system of work to another, clarifies this problem and so can furnish research principles capable of restating certain classic problems of industrial sociology.

The evolution of industrial work can be defined as the passage from a system of skills to a technical system of work. During phase A the top category of industrial workers, the craftsmen, possess a skill, and intervene directly and according to their particular and personal methods of work in production. However subject to an economic and social system he may be, the worker possesses *job autonomy,* a vocational stronghold, and in his demeanor and attitude to his work testifies by his independent actions to this aspect of his job. If the notion of pride in workmanship makes sense only in certain historic, well-defined, social conditions which permit relations between the worker and the user of the product,[5] nevertheless the craftsman, in regard to his work, takes an attitude largely independent of its social circumstances. This is true because the worker is directly and physically involved in that work. It is his cleverness, the rapidity of his reflexes, his visual, auditory and tactical sensibility that operate the machine or tool, and, quite as much as his technical knowledge, determine the quality of his workmanship. It is because his strength, his good sense, his rhythm of work, the rapidity of his reflexes are constantly and directly put into play, even in planning his job, that the task possesses for him a certain autonomy.

Consider now the last phase of the job evolution (C), and observe that the worker no longer actively intervenes in the manufacturing process. He superintends, he records, he controls. His job can no longer be defined as a certain relationship between man and materials, tools and machines, but rather by a certain role in the total production picture. In a system dominated by technology most aspects of skill are now absorbed into the social aspects. The rhythm and character of the work is no longer determined by the nature of the product manufactured, or the machine utilized, or by the character of human effort, but by the way in which the work is organized. Whether or not the worker is qualified for the job depends now on his capacity to integrate himself into the social group and to take responsibility. At this stage the nature of a worker's qualifications can no longer be determined by the technical conditions of work, but to begin with by the social circumstances in which he performs it. It is even possible that with comparable levels of technology, other factors such as the kind of labor force obtainable, the management of the enterprise, the attitude of the workers to management, etc. . . . might result in quite different organizational hierarchies, administrative decisions, and working relationships. Education and promotion policies are also a factor. The worker under close supervision can be restricted to simple tasks which do not necessitate understanding technical problems; he can, on the other hand, work with more understanding by being associated with technical personnel and instructed and guided by them; he can perform his task mechanically, or exercise initiative and take the lead in innovation. These different possibilities are dependent on the psychology of management, supervision and workers, that is to say, on the state of human and industrial relations which, in turn, are social and organizational factors.

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[4] The same problem can be posed apropos of some other technical categories: techniques of leisure, of communications, of transportation. But it is not necessary here to enlarge on an already vast subject.

[5] We use here a remark of A. Haundicourt.

It is not a paradox to say that the new system of work, *precisely because of its technology, is entirely social and organizational.* For the workers, the work possesses a direction and value which depends entirely on social factors, a situation which is the opposite of that in which craftsmanship predominates. At this stage (C) an attitude which reflects simply the job as such no longer exists.

In place of the relative autonomy of a relationship that is limited to man as the possessor of certain occupational skills and to work as a situation where he exercises these skills, there is now substituted the relation between two totalities; on the one hand, the job, which mainly is social in its requirements; on the other hand, the worker, his social and organizational role, and his personality all considered together. It would seem to us that this widening of perspective must lead, not only to an enlargement of psychotechnology[6] but also perhaps to an overhauling of many of the principles and methods of that branch of study, in the light of the relative unimportance of job skills in comparison with social elements in the organization of work.

What is true of phase C is also true of phase B, but the problem here is more complex.

During phase B while the values of skilled work are being in effect destroyed, the debris of the old system has not yet been eliminated, and a very large number of men are held down to work of an extremely simple, repetitive nature, often nothing more than machine tending, such as characterizes the big mechanized manufacturing industries, particularly textiles. But if the importance of monotonous over-specialized work is evident, one cannot conclude from this that the job itself is an autonomous factor in the work situation. On the contrary, psychologists of work, such as L. Walther, who consider work only from the aspect of the task itself, characteristically conclude that unconscious work is necessary. They recognize by this that the job no longer makes sense to those who do it, and on this plane cannot again be made worthwhile or humanized. This is another way of saying that whether or not work makes sense depends entirely on aspects other than the actual task, on social aspects, that is to say on the degree of social participation of various kinds by the worker. Unskilled work is thus in phase B for most men already entirely social in nature. Beyond official and purely formal designations, the job can actually have an entirely different value and meaning for those who perform it according to their social relations with those about them.[7]

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[6] By this is meant the studies of industrial psychology which deal with aptitudes, vocational guidance, etc.

Perhaps the foregoing remarks enable us to make precise the opposition which G. Friedmann insists upon between the *milieu naturel* and the *milieu technique*. It is apparent that technological developments of all kinds place man in a newly conditioned psychosociological environment. But perhaps we should add, that, although his environment in phase A is already to some extent affected by technology, man remains in relation to production a natural being, often the source of energy himself, and in any case an element in production which cannot be dissociated from the tools or machines that he utilizes. Phase B marks the complete disappearance of the natural environment, while with phase C there is permanently installed a system where work is completely determined by technology. The preceding remarks show that in speaking of a system entirely determined by technology, one is not stressing the importance of technological conditioning of work, but on the contrary, the disappearance of vocational conditioning and the return to a real unity in the work itself, now become entirely social.[8]

Social does not sufficiently clarify what is meant in regard to the problem of work because of the many different ways this word is used. One cannot draw any inferences in favor of the new factor or as to its particular value.

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[7] This principle runs the risk of misinterpretation unless two remarks are added: (a) No hypothesis can be made a priori at this stage of the analysis on the importance of different social aspects of work. (b) It cannot be expected that the validity of the principle advanced here can be proved by showing that the trend toward the entirely social character of the job has been completed. Consequently, the observer must recognize in the behavior of groups of workers in socially different situations, common elements, insufficient by themselves, but constituting a relative check on the diverse ways that the social values of which we are speaking assert themselves. We do not think that it is possible to isolate attitudes to work that are not affected by social conditions which surround the job, but we also do not think that any society has developed a system of values in industrial work that is entirely unique.

[8] In recalling here the expressions employed by G. Friedmann, we do not intend to suggest that he accepts our conclusions.

It is necessary to analyze the relations which exist between different forms of social participation—human relations in the enterprise, level and type of consumption, participation in the social order, family life, etc. These are new and vast problems. We have indicated elsewhere the principles which must guide the analysis, that of the relativity of systems of value.[9]

From the principles that have been defined we can deduce a certain number of consequences which merit special study and which will only be indicated here.

1. The subordination of those aspects of the job concerned with skill to the social and organizational aspects, rules out of phases B and C the illusions of the technocrats. That in the course of the development of industry the role of the technician will be increased is incontestable, but output and productivity depend more and more on organizational and social factors, the "climate" of the enterprise, and above all on the attitude of the workers to their work. The relations between the technicians and the workers are an important element in this climate but its amelioration supposes the overcoming of all narrow managerial ideologies and in particular overcoming the present division between technicians and workers, an accomplishment which would actually contribute to technical efficiency. To consider a plant from a purely technical point of view is in opposition to different groups playing the social role which is now theirs and yet this role in a large measure governs the progress of productivity. Thus the evolution of technology condemns the technocratic spirit when it is invoked unduly.

2. More important, and more positive, are the repercussions of the suggested principles on vocational training. Beyond simple job training, vocational instruction strives to give to apprentices a real understanding, in a rational form, of the processes which will permit the worker to adapt to a wide variety of skilled work. But this clashes with the brutal reality of millions of unskilled or semi-skilled jobs which require no general vocational training. Some honest observers even ask themselves if the good intentions of the educator do not tend to aggregate the difficulties of subsequent adaptation by accentuating the opposition which exists between the aspiration for a true skill or craft, and the usual trivial job in industry. The nature of phase B and phase C suggests that this difficulty comes from opposing to the real character of work in these periods the mythical ideal of the craftsman of phase A.

Any vocational training which is to have value must be completed by social education, that is to say the preparation of the worker to be a social being and not simply a production worker. Such preparation must interest itself in every aspect of the worker's life, considered as a whole, and not only his work. Nor should it consider his leisure time activities solely as compensatory for his work.

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[9] See A. Touraine, "Ambiguité de la sociologie industrielle américaine." Cahiers internationaux de sociologie, vol. 12, 1952.

The enlargement of vocational training into social training cannot be achieved solely by administrative measures; it supposes the participation of the workers in the life of the enterprise, which appears to us to be required by the technological and vocational evolution of industry beginning with phase B.

3. The enterprise considered as a social system has been studied in the classic works of American sociology, but in a perspective which has in general been pragmatic. The sociologists too often describe the enterprise studied not in order to define the nature of the different groups or to understand the conflicts which develop among them, but to assure the best possible integration of the worker and the enterprise without modifying the more general characteristics of the latter. It is necessary to correct this point of view by a careful historical study, placing observed realities in the pattern of the general evolution.

The problems of informal organization in shops and factories can be understood only in the framework of the three phases which we have outlined here, and which do not appear as a separate aspect of the problem of the evolution of skills. Phase A is characterized by an extensive unity of formal and informal organization. Because work is still "natural" there are "natural" qualities which confer both formal command and informal leadership. The oldest journeyman becomes most often the foreman, or in practice functions as such, and he is also spontaneously recognized as a leader by the other craftsmen. The latter in their turn, not only direct the work of their assistants, apprentices and unskilled laborers, but become leaders through the prestige of their experience and competency. This is well illustrated in the coal mines, where one can distinguish the formal and informal elements which confer on the skilled coal miner a superior status to his helpers and the other ranks of workmen. This does not exclude the possibility of conflict between workmen and management's agents. Conflicts, on the contrary, are frequent—between workers and foremen in the mines—but these are *social conflicts.* It is important to observe the ambivalent attitude of the workman in phase A toward his supervisor, an ambivalence which reflects the double role of the latter who is both a representative of management, charged with determining the earnings, and at the same time a skilled worker capable of taking over a difficult job. The fact that the job is "autonomous" does not mean that there are no social problems and conflicts; the fact of autonomy is only one element in a complex, contradictory situation.

The advent of phase B in a social climate dominated by the technician accelerates the complete separation of formal and informal organization. But if in the formal organization man is considered simply as an element in the system of production, nevertheless an informal social organization develops spontaneously. American sociology has analyzed this remarkably well. And already in phase B during the evolution towards phase C, the need to consider the social factors that make for productivity brings a rapprochement of the two organizations, inasmuch as the role played by the social situation in work must be the new criterion of job qualifications which can no longer be understood in a narrow technical manner. Also, in the U. S., as in the Soviet Union, although in a very different perspective, one sees that such a rapprochement of the formal and informal systems of organization can lead to an identity of the two. This is the symptom of a coherent system of work; the separation of the formal and the informal organization during phase B testifies, on the contrary, to the transitional and contradictory nature of that phase.

What has just been said of informal organization applies also to the whole picture of human relations in an enterprise and to the problems of supervision and communications. Thus a majority of the problems most often treated by industrial sociology can be re-examined by the method of historical observation.[10]

4. The same must be true for the study of the labor movement. How can one fail to suspect a relation between a period dominated by phase A and craft unionism? The industrial unionism is characteristic of pure phase B as a type of union organization which opposes the economic and social system just as the informal organization of the factory opposes the formal organization. Should we not then have foreseen that there would develop a unionism integrated into the life of the enterprise and corresponding to the possibilities of phase B and the exigencies of phase C? Soviet trade unionism is the extreme example of this.

It would be dangerous to write the history of the labor movement solely as a part of the history of change in job skills in industry, but the marked correlation between the two is an important element—although not to be considered in isolation—necessary to the understanding of work. The goal of such understanding is a realization of the triple evolution of the technico-vocational realities, the economico-social realities and the working class movement.

5. In a general way, study of the evolution of job skills does not justify the pessimistic idea that mechanical work poses problems that no social transformation is able to resolve until technology itself has done so through automation. Until that day the pessimists say one can only diminish the gravity of such problems by reducing the working day, improving the use of leisure, and ameliorating physical conditions of work.

If one must recognize that only automation will cause *certain* problems to disappear which today are everywhere in all social systems, one must maintain nevertheless that the significance of work for the worker depends on the degree and way these problems are resolved in the society where he lives. If technological facts are found to be almost identical in all societies which have reached the same level of industrial development, it is equally true that the closer one approaches to phase C, the less the value of work can be defined on a plane of the actual technical character of the job and the more it varies according to the extra-job satisfactions that society permits the worker to find in his work.

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[10] A. Touraine, "Sur les transformations de la structure du travail dans l'industrie moderne," *Droit social,* mai, 1952, pp. 306–312.

It is in this way that one must understand the relative nature of the job qualification which has been suggested—a dangerous formula if one continues to define the job qualification technically. The formula makes sense only if it is related to the emergence of *social* qualifications for the job and to the need for a general psychosociological definition of work. The qualification becomes relative only to the degree that it incorporates a larger reality, that of the social meaning of work.

Finally, we must remind the reader that these conclusions apply in a strict sense only to the most highly developed situations in factory work, those nearest automation. They constitute only a partial principle of analysis for the facts most commonly found in phase B, since B partakes of the old system of job skills as much as of the new system of technology. In phase B, the social aspects of work tend progressively to give it a positive meaning at the same time as it becomes, from a traditional, purely occupational point of view, more and more negative and inhuman. The problem of leisure poses itself in this perspective in a new fashion, no longer as a search for compensations, but as an essential part, as much as work itself, of the system of valuation which gives to the job a certain status in the society and, by way of consequence, which determines its meaning for the worker. One can find realized in certain work communities an incontrovertible example of such a concept which the professional study of work, for its part, would do well to examine.

This study of the Renault factory should have shown that the establishment of a technical milieu, far from signifying the domination of technological facts, and their at least partial autonomy in regard to social conditions of work, supplants this autonomy which was characteristic of a system of craftsmanship and makes the meaning of work depend on social conditions. Assuredly here and there the machines employed are the same, but the important thing is to recognize that this uniformity creates no isolable and general factor of behavior, for the subdivided jobs of phase B and the work of the "technician" in phase C, have no longer for the individual any sense of craft, and receive all of their significance from the total social situation of the shop or factory. In addition every society permits its own particular social valuation of work.

These two conceptions, touching the relation of technology and social life in contemporary industrial societies can lead only to very different theoretical and practical attitudes concerning the principle problems of work. On the one hand, in studying the problems of man at work, one may not neglect the social aspects, but in describing them, grant a certain autonomy to the different points of view, in particular to the psychotechnical analysis of work. On the other hand, one may search for the essential unity of each system of evaluation, believing that none of the elements should be considered in isolation. . . .

III. *The Study of Work.*

These remarks call for a more general conclusion touching the *method* to be followed in the study of work. The greater part of research actually taking place, particularly in the United States, is inspired by a psychological, pragmatic and reformist point of view. The sociologists, and above all the psychosociologists, are anxious to realize the "social adjustment" of the workers. In studying conditions and the psychological obstacles to this adjustment in a given social milieu, that of American industry, they accept it as a frame of reference not only for research, but for action too.

Thus there is constituted a science of work which most American researchers recognize—whether they congratulate themselves on it or find it unworthy—that seeks to be a substitute for the working class movement. A socio-technique is being created that can be considered as an enlarged and rejuvenated form of Taylorism, although distinctly, and rightly, it is opposed to the primitive forms of scientific management.

In place of this point of view, one must, it seems to us, substitute a method that is first of all historical and comparative. This means that the psycho-sociological problems of man at work must be studied as a function of the work itself and its own problems, of which the evolution in job skills is only one of the aspects, but an aspect that is both important and poorly understood.

To proceed thus does not get rid of problems but places them in a proper sociological perspective. It guards against certain excesses as when psychology and psycho-pathology cease to be scientific research in order to become arms of politics. The role of a science of work is not to act as a substitute for real forces and conflicts, but to clarify them. Its possible applications must not be confused with prescriptions, proposed by management, that are spectacular rather than truly effective.

The study of man at work is exposed to dangerous errors if it does not rest on the study of work itself, on the principles of the unity of its several aspects, and their reciprocal relationship.

To begin with, it is through comparative studies that we will arrive at a scientific approach. Too few direct observations and objective studies have been made in France. The inquiries followed within the *cadre* c the Centre d'études sociologiques can be a point of departure for research that is more extensive and more profound. The study conducted at Renault has made it possible for us to propose a descriptive framework and certain principles of interpretation. Parallel inquiries undertaken in other industrial sectors would enable us to judge our accuracy and to make more precise ideas which still depend on a too limited field of observation.

5. WORK AND LEISURE UNDER INDUSTRIALISM

From Clement Greenberg, "Work and Leisure under Industrialism," *Commentary*, vol. 16, no. 1, pp. 57–61, July, 1953.

There has been much talk about how the new leisure created by the shortening of hours of work can be turned to the advantage of humanist culture by providing it with a broader social basis than ever before. Leisure is seen as not a matter merely of free, empty time, but as also determined by the material and social circumstances under which it is enjoyed. What is not realized, however, is the even greater degree to which it is determined by the kind of work, or necessary activity, that sets it off. Leisure—even for those who do not work—is down at bottom a function of work, flows from work, and changes as the nature of work changes.

Leisure in traditional society (the "peasant," feudal, semi-feudal, or merchant's society which was the most we knew until two hundred years ago) was—for most classes in theory, and for the upper classes that supported high culture, in practice—the *positive* aspect of life, and the condition for the realization of its highest values. Economically productive work lacked prestige, as we know, and was regarded as life's negative aspect. (However much the peasant or farmer has praised himself since time immemorial for doing such work, it was almost always with the resentful feeling that nobody in city or manor really agreed with him.) But even more fundamental was the fact that purposeful work was not separated from all that was not work as sharply and unequivocally in terms of time, effort, and attitude as it is now. For one thing, most work used to be work on the land, which is difficult to compartmentalize in terms of time; for another, traditional work was adulterated more or less by irrational practices—customs, rites, observances—that, conceived of originally as means of helping work achieve its ends, then becoming ingrained as matters of propriety and custom, actually furnished occasions *inside* work for relief from the strain of its purposefulness. With the distinction between work and leisure blurred in this way, culture could preserve a certain place and role within the former—at the cost, to be sure, of its efficiency.

Whether work was rendered much less of an affliction thereby is debatable. But the easier or more "natural" rhythm and pace of traditional work did, it would appear, take a lighter toll of the nerves—and if the working classes of traditional society lived more brutish lives than ours, that may have been not so much because they toiled like beasts of burden, but because they had less material goods at their disposal as a result, precisely, of the fact that they did not work hard or rationally enough. The upper classes, at least—those whose members did not perform manual labor—were able to take fuller advantage of the orientation of traditional work towards leisure, and turn it to the benefit of high culture as well as of themselves, while escaping most of the consequences of its low productivity.

To the exact end of greater productivity, capitalism, Protestantism, and industrialism have brought about a separation of work from all that is not work which is infinitely sharper and more exclusive than ever in the past. And as work has become more concentratedly and actively work—that is, more strictly controlled by its purposes, more efficient—it has pushed leisure out of the foreground of life and turned it into the negative instead of positive complement of itself. Work may be less arduous physically than it used to be, but its present standards of efficiency require one to key oneself to a higher pitch of nervous and mental effort, if only for the sake of the self-control and self-denial required by any kind of sustained activity directed solely towards an end outside itself. Leisure, in compensation, has become much more emphatically the occasion for flight from all purposefulness, for rest, respite, and recuperation.[1] It is certainly no longer the sphere *par excellence* of realization, but a passive state, primarily, in which one's least passive need is for distraction and vicarious experience that will give those immediate satisfactions denied one during working hours by the constraint of efficiency. This in itself is a valid need, but when one's nerves insist that it be met with a minimum of mental exertion on one's own part only a base kind of culture can satisfy it, a kind of culture that has lost all efficacy as recreation (in the literal sense) and become entirely a matter of rudimentary entertainment and diversion—of the sort, exactly, that we see in lowbrow and much of middlebrow culture.

This new relation between work and leisure—which I have simplified and exaggerated in order to describe—would have less of an effect on culture, and particularly on high culture, were the rich still exempted from work. But as their monopoly on comfort has been broken by industrialism, so has the monopoly on economic work of those who are less than rich (as though industrialism could shorten working hours only by making work universal). The upper classes can no longer say to the rest of society: "Work—that's your fate, not ours." Status and prestige are not derived so implicitly as before from social origin, and are conferred more and more preponderantly on achievement, and sustained achievement at that. Old-fashioned, complete leisure is now felt by the rich, too, as idleness, as remoteness from reality, and therefore the way to demoralization, thus no longer presupposed as the natural and positive condition of the realization of the highest values—much less as the end for which one strives in youth as well as old age.[2]

In this point if no other, Puritanism has won a lasting victory. Work has now become the main business of life and the ground of reality for all classes of industrial society. And while the rich man may be far less "alienated" from his job than the poor, he is subject to the same "banausic" rule and pace of efficiency, which transform his leisure, too, into one without mental ease, a series of breathing spells, no matter how extended, in which it is difficult for him, too, to collect and recreate himself.[3]

The highest level that humanist culture seems to be able to attain under this new kind of leisure is the middlebrow. And according to the evidence we have so far, the quantitative increase and diffusion of such leisure do not promise of themselves to raise that level very much. Nor would the restriction of social movement, the further improvement of standards of living, or even the raising of standards of public education—not of themselves, not as long as leisure, and work, remain what they have latterly become for everyone.

Marx expected socialism, with a working day of four hours or less, to solve the problem of culture under modern industrialism (a problem to which he did not, for that matter, give a great deal of thought), but work, and efficiency in work, would still be necessary to the success of an integrally socialist as to any other kind of industrial order, and leisure, no matter how much enlarged, would still be dominated and enervated by work, and colored by the anxiety that the rule of efficiency seems to provoke wherever it is "internalized"—as it must be if industrialism is really to function.[4]

Nor is it likely that the presumably greater security of life under socialism would radically lessen that kind of anxiety and the demand for anodynes to relieve it. Thus not purely political or economic, not purely social or cultural measures appear to promise to solve the problem of authentic and high culture under industrialism—not as long as it goes unsolved in the sphere of work.

It is doubtful, moreover, whether that solution could be achieved merely by so changing work as to restore leisure as the theater of genuine culture while leaving work, or before, outside. This would require making leisure again the positive aspect of life and work the negative one. But this is impossible under full-fledged industrialism because it would mean relaxing efficiency. Industrialism, with all its burden, its work and routine, is accepted by and large because it opens up and begins to realize—for the first time—the prospect of a higher level of material well-being for all classes; to slacken efficiency would postpone that realization, and to this the mass of people in a country like ours, where the awareness of the relation between such causes and such effects has become almost universal, will not consent. If, therefore, the problem of achieving an authentic culture under industrialism has to be solved without reducing efficiency, or else not at all, then the only way out becomes the highly improbable one of making work itself the main sphere of culture—that is, of integrating it with culture *without* sacrifice of its efficiency. Which is also to say that work under industrialism, whether in factory or office, must be made the source of more immediate satisfactions for those who perform it.

The problem as stated looks so formidable, so unprecedented, that one's first impulse is to cast around for alternatives. May we not ask, with Sir Herbert Read, whether it won't be possible for authentic non-utilitarian culture to develop in industrial leisure on the basis of the kind of interest and activity that go into the hobby? May not leisure in that way be infused with some of the positive spirit of work and redeemed from its passivity? As it happens, the hobby is in its nature and history closely tied to industrialism. It has taken hold only during the last two centuries and, as distinct from the dilettante's or leisured man's avocation, can be defined as a homeopathic reaction from the purposefulness of serious and necessary work (or acquisition) that takes the form of work (or acquisition) itself. One works at the hobby for the sake of the pleasure in work, and is able to take pleasure in it because its end is not serious or necessary enough to subject its means to the rule of efficiency (though one can make a hobby of efficiency too). The hobby asserts the value of one's time and energy in terms of immediate rather than ultimate satisfactions, and relates the end of work directly to the particular person who performs it.

The hobby is play, and play, according to Jan Huizinga, is the mother of culture. But play as such, under industrialism, is no longer *serious* enough to open the way to the heart of things—is rather a detour or escape. Authentic culture must, by definition, not be that. It has, instead, to lie at the center, and from there irradiate the whole of life, the serious as well as the not serious. It is serious work that has become, as I have said, the center of all our lives. If serious work—not leisure—can be infused with something of the spirit of the hobby, with something of its unseriousness, well and good; but not the other way round—not as long as leisure remains peripheral, as it must, and the hobby finds its only existence there.

But looking again into the remoter past, we discover that the necessity of integrating non-material culture with economic work is not altogether novel. We have only to follow traditional society far enough back. In certain respects, as Marx saw, we have come full circle. Everyone, as a rule, had to work in primitive societies, as they do now in an advanced industrial one. This made the question of culture in early societies, too, coincide largely with that of work, for they likewise had no leisure class to carry on culture as something apart from work. But these societies solved the problem automatically: that is, it did not exist before its solution.

The remoter pre-urban, and archaic urban past shows us art, religion, and lore, not only as barely distinguishable from one another in practice, but also as hard to distinguish, in intention, from the technologies of production, war, and healing. Rite, myth, magic, decoration, image, music, dance, and poetry appear to have been art, religion, lore, defense, work, and healing at once, all of them parts of a single complex meant to safeguard mortal existence. Five thousand years of urban history have gradually separated these activities, with their implicit ends, and sealed them off from each other, so that we at last have art (or culture) for its own sake, religion for the sake of things knowable only outside life (or, like art to some degree, for the sake pure and simple of states of mind), and work for the sake of exclusively practical, "objective" aims. The problem now is to restore intimate relations between the three, or—with religion, as I think, ruling itself out as a social form—between the two. For if culture cannot be again closely related to work, it cannot be related closely enough to that reality which has again become fundamental for all of society.

Industrialism, imposing work on everyone—without, by that fact, doing away with exploitation—has confronted us more explicitly than ever before with work in its aspect as a limitation on human freedom—the aspect the author of Genesis must have had in mind when he described the fall of man (and beginning of history) as a fall into reproduction, work, and death. If man is to continue discovering and realizing his possibilities in history he will, at this point, have to broach the problem of culture and work—which is to say, of his mastery over work—more radically than he has so far.

It may be that industrial man will not be able even to begin to solve the problem;[5] it may be that the problem is permanently insoluble. But if so, then Eliot will have been right, and a revival of high, authentic urban culture must await the collapse or retreat of the industrial system, and the re-emergence of a leisured ruling class on the basis of a new form of the old order and of an economy of the old scarcity and squalor. . . . In the meantime, high culture, on its non-aesthetic side, may be able to survive as a set of special disciplines practiced during working hours by professionals—and to the extent necessary for the maintenance of the skills and knowledges required for the operation of the industrial system—but not as art, not as humanistic culture, not as something that informs, and is nurtured by, the presence of the mere well-educated citizen. And then high culture, as a department of industrial work—that is, as a thing worked at but not flowing from work—will impose the same strain as every other kind of industrial work, and the mandarins who work at it will have to devote their leisure to recuperation the way the rest of us do.

This is a speculation, not an assertion. The ingenuity shown by man in solving his social problems in the past—and especially in the pre-urban past—gives reason to hope that he will eventually solve this one too. The solution will not guarantee his happiness, but it will, if found, certainly make him more human.

Notes

1. The difference between modern and traditional work lies in this tension, and not as much as is commonly thought in the difference between the machine-tending "robot's" boredom and the solicitous interest and commitment of the craftsman who shapes the product of his work from beginning to end. It is forgotten that only a small proportion of traditional work was done by craftsmen; most of it was labor, drudgery, in town as well as country, and of a kind demanding even less use of the intelligence than does factory work.

2. See Aristotle in his *Politics*, VIII, 1337B and 1338A. With his customary psychological realism, he reports the common view, held from the dawn of urban civilization until a short while ago, of leisure as the highest condition of life for the young no less than the old: ". . . we should be able, not only to work well, but to use leisure (*schole*) well; for, as I must repeat once more, the first principle of all action is leisure. Both are required, but leisure is better than work and is its end; and therefore the question must be asked, what ought we do when at leisure? Clearly we ought not to be amusing ourselves, for then amusement would be the end of life . . . we should introduce amusements only at suitable times, and they should be our medicines, for the feeling that they create in the soul is a relaxation, and from the pleasure we get rest. But leisure *as such* (my italics) gives pleasure and happiness and enjoyment of life; these are experienced, not by the busy man, but by those who have leisure. . . . there are branches of learning and education which we must study merely with a view to leisure spent in intellectual activity, and these are to be valued for their own sake. . . ."

3. Also important is the difference between a leisure supported by servants and one in which you have to fend for yourself with the aid of "modern conveniences" and labor-saving appliances. A single housekeeper provides more ease than a thousand gadgets, as Schumpeter says.

4. Once efficiency becomes a matter of conscience, the failure to be completely efficient—or even to be able to imagine what the perfection of efficiency is—weighs like a sense of sin. For no one is ever efficient *enough*.

5. We do, I think, get a glimpse—if only that—of a part of such a solution in architecture, the healthiest of contemporary arts. The revival called the "international school" and—with less accuracy—"functionalism" is due in great measure to formal architecture's having, for practically the first time, been given the task of designing places of work. And in this task it has benefited from the growing realization on the part of industrial experts that cheerfulness and comfort can be as essential to efficiency as the more literally functional qualities of a building. That some number of people now get an immediate satisfaction from the décors in which they work such as they do not

from the décors of their homes, and that this is provided by advanced, "highbrow" architecture, may be considered at least one gain for high culture under industrialism.

6. CAN TECHNOLOGY BE CONTROLLED?

From W. H. Ferry, *The Corporation and the Economy*, Center for the Study of Democratic Institutions, Santa Barbara, Calif., 1959, pp. 107 ff *passim.*

[The following selection is drawn from the published draft of discussions that were presented under the auspices of the Center for the Study of Democratic Institutions on April 26–27, 1959. The basis for discussion at these meetings were notes prepared by W. H. Ferry, vice-president of the Fund for the Republic, who based his comments on studies, conferences, and seminars that have been carried on in connection with a project of the Center designed to study the corporation as a part of the United States economy. The participants in the meetings were A. A. Berle, Jr., Scott Buchanan, Eric Goldman, Clark Kerr, John Courtney Murray, S.J., Reinhold Niebuhr, and I. I. Rabi; consultants were Robert M. Hutchins, John Cogley, W. H. Ferry, Hallock Hoffman, Paul Jacobs, Frank K. Kelly, Walter Millis, James Real, and Edward Reed. Ferry, in his notes, presents various ideas, arguments, and questions which are later commented on by the participants. One, of particular interest here, is that "technology imposes novel demands upon both the economic organizations and society as a whole. The implications of technology for the future are overwhelming. Its direction and its most significant products should be brought under public control."]

Technology and Bureaucracy

Technology is the lifeblood of the economic system, as bureaucracy is its nervous system. Technology, taken to mean organized knowledge and techniques, is neutral; that is, it is value-free, and its products can be used for general good as for general ill. Technology is a common resource, and the dominant fact of our lives. We choose to have it this way, and under-developed nations see technology as the only desirable line for them to take. In writing its own rules it writes many at the same time for society. Changes in tools and techniques produce violent changes in political and social relationships. It has been observed that military policy is decided by weapons technology, and not vice versa. Dramatic as fusion-fission technology may be, it is nevertheless only one of many developments that are sure to effect drastic transformations in the human condition. Geneticists appear to be on the way to discovering thoroughbred mating, so that we can if we will obtain a standard quality of human being. Biochemistry has already produced elementary forms of life. None can yet tell whether throwing a radiation belt around the world is a great benefit or a precursor of disaster. Tranquilizers will be succeeded by happiness pills and doubtless unhappiness pills. Already technology is producing spectacular alterations in society; one thinks of the effects wrought by television and automation in little more than a decade. These are collective, not occasional and individual, effects. The question would seem to be, what do we need to do to live with the knowledge now coming into our possession?

History is not of much help in answering the absolutely novel questions posed by technology. Some kind of public appraisal, planning, and control of the most powerful, dangerous, and influential products of technology would appear to be indispensable. The imagination is staggered by such a notion. We have been used to thinking of technology as a positive good that should be allowed to develop unhindered by any restraints except perhaps those of the market.

Despite the immensity and intricacy of the task, the control of technology still appears possible, even though unlikely. Private and public organizations show us some of the methods of cooperation and direct control that may have to be called on. Du Pont often publicizes its Chart Room, where decisions are made about the rate at which the company's technological innovations are to be permitted to flow into the market. Here plans are also made to assure that the market is ready and receptive. Weather ships under international control dot the oceans, and are an integral part of world-wide meteorology. The International Labor Office facilitates the exchange of information on the effects of automation and other technology affecting working people.

Out of such examples it may be possible to erect the rudiments of a control system. Public appraisal of the potential social utility of technological advances—perhaps by an agency like the one described earlier—would appear to be needed immediately. It can scarcely be doubted that appraisal of automation might have considerably eased its impact, and might even now allow us to deal with its implications for a free and decent society far better than we are doing. "We are in danger of forgetting the principles of political liberty in our concern to keep the machines running."

Bureaucracy is a necessary condition of an "industrializing" society, and indeed of any large organization from the Post Office to the trade union to the fraternal organization. Well over 80 per cent of those gainfully employed off the farms are in corporations, large and small. Corporation life, as factory worker, bureaucrat, or manager, is the common destiny of Americans.

The progress made by the economic order in conquering the forms and methods of bureaucracy has been brilliant. But the result of bureaucracy is a different question. Where the factory employee is concerned, the problem is one of work, its satisfactions and discontents, and of his union or lack of one. For that great group of men and women now in transition between blue collar and white collar the change of status brings new satisfactions and new perplexities. For the first time there is the possibility of the widespread "enjoyment of work," with few suggestions however as to how to achieve it. (Many in fact argue just the other way; that work is an insoluble problem, "enjoyment of work" is a contradiction, and most work is necessarily mean, monotonous, and arduous; and in any case technology, by bringing the 20- or 24-hour week, will make it of minimal importance, soon to be replaced by the problem of leisure.)

While automation and other advances herald a stepping-up of the skilled groups, there is yet no chance of "return to personal craftsmanship." The new technology may enable some workers to escape the grinding routines of the factory. There will still remain the problem of finding in work something worth doing for its own sake. Over the past two generations trade union activity has brought pay and fringe benefits and conditions of work to remarkable heights. Now the unions are starting to worry about whether the industrial machinery of the nation can or should be geared to produce larger quantities of satisfaction, together with a sense of freedom and justice, for those participating in it.

Where the white-collar employee—bureaucrat and manager—is concerned, the problem is that of *anomie*. With the best will in the world many managers are struggling with the facelessness of corporate life. How successful they are depends on the standards that are used. Decentralization has, for example, meant more authority for more men. But company security systems and pensions and other benefits tend to lock many more into their jobs. There is, moreover, devotion to the proposition that the welfare of the employee and that of the employer are identical. There is little disagreement with Andrew Hacker's point that for a variety of reasons the corporate employee's primary commitments are to his company and not to his community or even to his own self-development.

As troublesome a question as any is how a sense of individual worth and dignity may be made of compelling importance to a bureaucratic population that shows little sign of prizing these qualities. . . .

HUTCHINS: There is one aspect of the planning problem that you may want to express yourselves on. That is the relationship of planning to technological development, or the problem of the control of technological development and whether that is possible. At a meeting of the advisors to the Corporation Project, Mr. Hacker of Cornell took the position that this was ridiculous. He said there was no way in which you could guide or direct technological development, and you might as well forget about it. Ferry's paper recommends guiding and directing technological development in the public interest, concluding, therefore, that the planning would function.

GOLDMAN: That is the place where it would be most successful.

HUTCHINS: Mr. Hacker's argument was an argument from history. It has never been possible to do this.

MILLIS: My tendency would be to sympathize with Mr. Hacker. It seems impossible to me that this could be brought down to factual and precise statements. What do you mean by guiding technological development?

RABI: It is very difficult. Take the case of EURATOM. Around the time of Suez it was clear that Europe would be dollar-poor and oil-poor and coal-poor, and they thought of atomic-energy development. Now coal is a glut on the market and oil is a glut on the market, and so on. There is a case of long-range planning. It is probably still correct, but it would be awfully difficult to convince people to go on with it. The prognosticators are so poor. If you knew the conditions, and knew the laws of the thing you were discussing, then you could program it like a computing machine. There would be no problem. The only problem you would have is in formulating the desires. Then we would know how to do it.

FERRY: The suggestion was made in the paper that arguing from history would not get us very far because of the kind of developments we have seen in the last few years, the most spectacular of which is the bomb, of course. Other instances given are developments in genetics, developments in the use of drugs. If it is possible for a people totally to change its outlook, let us say, by the use of drugs, the question is what, if anything, should we do about this? Perhaps the analogy with the du Pont chart room is wrong. It is, however, an impressive story.

Du Pont says they are in the business of technology and so they develop and perfect and then hold things off the market until the market is ready to receive them, for commercial and other reasons. The story of holding nylon and dacron off the market until the market could be prepared properly for their reception is a fascinating one.

This may be an imperfect analogy. It is intended to show private planning of technological development. It seems to me, however, that we may have similar situations in other areas, and society ought to take the means of protecting itself or dealing sensibly with technology, which it will not necessarily cope with as successfully tomorrow as it has in the past. The question is: What do we need to do to live with the technological knowledge now coming into our possession? . . .

MILLIS: I am uncertain about what we are talking about when we are talking about control of technology. We are speaking of two controls.

One would control the impact of technology on the social structure and provide for people thrown out by automation, for example. The other is the control of the impact of technology not on just one group of workers but upon the whole shape of our lives. I don't know any answer to Kerr's argument that this latter form of control is impossible. I don't see how it can be done. If Ferry or anybody else has an idea of how it could be done, I would like to see it. . . .

KERR: In terms of technology over-all, it would be absolutely impossible to do anything about it. Let us grant it does some horrible things to society. It also does some wonderful things. Technology is so all-pervasive that you could not have a commission on technology to do anything about it. As individual things come along, as the automobile came along, you do start certain rules for their use. You can tackle certain aspects of new technological developments where they get out of line with the public interest. But to talk about some kind of a commission to study technology over-all or some government commission to control technology over-all is absolutely impossible. This thing was unleashed on the world. It is going to keep on growing. We have no idea what the ultimate consequences are going to be. I don't know how you would ever tackle it. I think you can say that as things come along which may seem unfortunate to humanity, humanity will take them up one at a time. I don't see how you can look at the problem over-all. . . .

HUTCHINS: As I understand it, we are to think about technology as an aspect of the general problem of organizing the economic order. We agreed on an agency of criticism and we agreed on planning, subject to some qualifications. I don't see how technological developments can be omitted from this.

RABI: Some group looking at the society and trying to understand it is fine. We are all trying to do that, in the universities, in the Ford Foundation, the Fund for the Republic, and many other places such as the Twentieth Century Fund. We are trying to understand our society. There are many areas in which technology has been introduced and the race has not yet found good experience to cope with. We must observe the Russian experiment with great interest, because they presumably have the means of control built into the system, to see whether it actually works. But I can't see how the particular suggestion that was made here would work out.

FERRY: The whole proposition for appraisal and control of technology is built on Kerr's statement that technology is the pervasive fact of our lives. I prefer to think that we should remain in control of our own lives, and that technology should not take over.

RABI: Technology can't take over. I don't know how you personify this. You are talking about people who are pressing to do certain technological or other innovations or the effect of natural phenomena, like the melting of the polar ice cap, the warming of the oceans. These things will be happening and people will be doing things with them.

FERRY: Would you dispute Father Murray's statement that weapons technology decides our military policy?

RABI: Certainly. Our military policy is decided by natural objectives within the confines of what we can do. But our national objectives decide our military policy. We don't have to indulge in a cold war with Russia. We could just say, "We will join you." To begin with, there is a certain national purpose, and then the military technology gives the means for doing it. Not only ours, but theirs. Once you look at it in that way, it is clear that we are not free agents. Once you decide a certain line of action, you are not free agents, just as if you were in business.

MILLIS: Any decision of such a commission or so on would have to be political in the large sense.

RABI: In the framework of a political-social objective of some kind.

FERRY: That is the basis of the suggestion in the paper—to try to make *social inventions* requiring far greater skill and imagination than anything that is so far proposed. [Italics added.]

7. THE FUTURE OF MAN

From Julian Huxley, "The Future of Man," *Bulletin of the Atomic Scientists,* vol. 15, no. 10, December, 1959.

Science provides increased control over the forces of nature, and so gives us the means of realizing our aims in practice. But it also provides fuller understanding and a truer vision of natural reality. This is in the long run the more important, for our vision of reality helps to determine our aims.

Humanist Era

By discovering how to control intra-atomic energy, science has launched us into the Atomic Era, with all its attendant hopes and fears. But by giving us fuller comprehension of nature as a whole, it has set us on the threshold of a greater and more revolutionary age, which I will call the Humanist Era. It is the era in which the evolutionary process, in the person of man, is becoming purposeful and conscious of itself.

Today, for the first time in man's long and strange history, science is revealing a comprehensive picture of the natural universe and of man's place and role in it—in a word, of his destiny.

Thanks to the patient labors of thousands of scientists—biologists and astronomers, geologists and anthropologists, historians and physicists—

the universe of nature in which man lives is now revealed as a single process of evolution, vast in its scales of space and time. Man is part of this universal evolving world-stuff. He is made of the same matter, operated by the same energy, as all the stars in all the galaxies.

Most of the universe is lifeless and its portentously slow evolution has produced only simple patterns of organization and little variety. But on our earth (and doubtless on other planetary specks) conditions permitted the appearance of the self-reproducing and self-varying type of matter we call life. With this, natural selection could begin to act and the biological phase of evolution was initiated.

Change Becomes More Rapid

Through natural selection, change—though still slow by human standards—could become much more rapid, and surprising new possibilities could be realized by the world-stuff. From the uniformity and relative simplicity of submicroscopic particles, there was generated the astonishingly rich variety of life, from sea-anemones and ants to cuttlefish and lions, from bacteria and toadstools to daisies and giant trees; the astonishingly high organization of a beehive or a bird; and most astonishing of all, the emergence of mind, living matter's increasing awareness of itself and its surroundings.

But there are restrictions on what the blind forces of natural selection can accomplish. A few million years ago, it now appears, living matter had reached the limits of purely material and physiological achievement: only the possibilities of mind remained largely unrealized.

By exploiting the possibilities of mental advance, man became the latest dominant type of life, and initiated a new phase of evolution, the human or *psychosocial* phase, which operates much faster than biological evolution, and produces new kinds of results. Man's capacity for reason and imagination, coupled with his ability to communicate his ideas by means of the verbal symbols of language, provided him with a new mechanism for evolution, in the shape of cumulative tradition. Pre-human life depended only on the transmission of material particles, the genes in the chromosomes, from one generation to the next. But man can also transmit experience and its results. With this, mind as well as matter acquired the capacity for self-reproduction. Natural selection became subordinate to psychosocial selection, and the human phase of evolution could begin.

Science has also shown man his position in evolutionary time. Life has been evolving on the earth for over two thousand million years. Man-like creatures have existed for only about one million years, and human civilization, with all its achievements, for a bare five thousand. But evolving man can reasonably expect an immensity of future time—another two thousand million or more.

The psychosocial phase of evolution is thus in its infancy: man as dominant evolutionary type is absurdly young. I may adapt a simile of Sir James Jeans: If you represent the biological past by the height of St. Paul's cathedral, then the time since the beginning of agriculture and settled life equals one postage stamp flat on its top. And, unless man destroys himself by nuclear war or other follies, he can look forward to evolving through at the least the time-equivalent of another St. Paul's.

Role of Man

Man's place and role in nature is now clear. No other animal can now hope to challenge his dominant position. Only man is capable of further real advance, of major new evolutionary achievement. He and he alone is now responsible for the future of this planet and its inhabitants. In him evolution is at last becoming conscious of itself; his mind is the agency by which evolution can reach new levels of achievement. Man's destiny, we now perceive, is to be the agent of evolution of this earth, realizing richer and ampler possibilities for the evolutionary process and providing greater fulfillment for more human beings.

The revelation of fulfillment as man's most ultimate and comprehensive aim provides us with a criterion for assessing our own psychosocial evolution. Already in its brief course psychosocial evolution has produced real progress—increased expectation of life, less disease, more knowledge, better communications, increase of mechanical power and decrease of physical drudgery, more varied interest, and enrichment through creative achievement—in buildings and works of art, in music and spectacle, in discovery and ideas. But it has also produced poverty and crime and slavery and organized cruelty, and its course has been accompanied by constant exploitation, indignity, and slaughter.

In this new perspective, we see that what Père Teilhard de Chardin called the process of hominization—the better realization of man's intrinsic possibilities—has barely begun. Few human beings realize more than a tiny fraction of their capacities, or enjoy any but the most meager degree of possible satisfaction and self-fulfillment. The majority are still illiterate, undernourished and short-lived, and their existence is full of misery and indignity. Nor have human societies realized more than a fraction of their capacities. They provide inadequate opportunities for expression and enjoyment, they still produce more ugliness than beauty, more frustration than fulfillment; they can easily lead to the dehumanization of life instead of its enrichment.

Science and the Future

What has all this to do with science? I would say a great deal. First let us remember that most of what we can properly call advance in psychosocial evolution has stemmed from new or better organized knowledge, whether in the form of traditional skills, sudden inventions, new scientific discoveries, technological improvements, or new insights into old problems.

Science is a particularly efficient method for obtaining, organizing, and applying knowledge. Though modern science is barely three centuries old, it has led to the most unexpected discoveries and the most spectacular practical results. Scientific method involves controlled observation of fact, rational interpretation by way of hypothesis, the publication and discussion of procedures and results, and the further checking of hypothesis against fact. The use of scientific method has proved to be the best way of obtaining fuller intellectual understanding and increased practical control, in all fields where it has been tried. It leads inevitably toward more and fuller truth, to an increasing body of more firmly established factual knowledge, and more coherent principles and ideas.

Science is often used to denote only the natural sciences; but this is a false restriction, which springs from the historical fact that scientific method could be more readily applied to simpler subjects, and so first became effectively applied in non-human fields. But it can be applied to all natural phenomena, however complex, provided that we take account of their special peculiarities and go to the trouble of devising appropriate methods for dealing with them.

Psychosocial Science

Today, the time has come to apply scientific method to man and all his works. We have made a piecemeal beginning, with psychology, economics, anthropology, linguistics, social science, and so forth. But we need a comprehensive approach to the human field as a whole. We already have physical science, chemical science, and biological science: to deal with man as a natural phenomenon, we must develop psychosocial science.

The primary job of psychosocial science will be to describe and analyze the course and mechanism of psychosocial evolution in scientific terms. It will also include a science of human possibilities. What are the possibilities of man and his nature, individually and collectively? How is their realization helped or hindered by different types of psychosocial environment? How can we estimate human fulfillment; in what ways and to what extent can it be promoted by changes in psychosocial organization? In particular, such a science will involve a radical re-thinking of man's systems of education, their aims, content, and techniques.

The value of such an approach and such criteria is clear when we look at concrete problems. Two new challenges have recently appeared on the evolutionary scene—the threat of over-population and the promise of excess leisure. The population problem obstinately resists solution in terms of power-politics, economics, or religion, but the criterion of greater fulfillment immediately lights it up and indicates the general lines of the policy we should pursue in reconciling quantity with quality of human life.

The new possibilities opened up by science are exerting two effects on psychosocial evolution. Increased scientific control over the forces of nature has produced a flood of new conveniences and comforts, and has led directly to death-control and the recent alarming increase of human numbers. But the knowledge that healthier and longer life is possible, and that technology can provide higher standards of living and enjoyment, has changed the attitude of the vast underprivileged majority: they are demanding that the new possibilities shall be more abundantly realized.

Limited Possibilities

The next step must be to grasp the fact that the quantitative possibilities are not unlimited. Unless present-day man controls the exploitation of natural resources, he will impoverish his descendants; unless he supplements death-control with birth-control, he will become the cancer of the planet, ruining his earthly habitation and himself with it.

The leisure problem is equally fundamental. Having to decide what we shall do with our leisure is inevitably forcing us to re-examine the purpose of human existence, and to ask what fulfillment really means. This, I repeat, involves a comprehensive survey of human possibilities and the methods of realizing them; it also implies a survey of the obstacles to their realization.

Let me summarize the new picture of human destiny from a slightly different angle.

Man is the latest dominant type of life, but he is also a very imperfect kind of being. He is equipped with a modicum of intelligence, but also with an array of conflicting passions and desires. He can be reasonable but is often extremely stupid. He has impulses to sympathy and love, but also to cruelty and hatred. He is capable of moral action but also has inevitable capacities for sin and error.

As a result, the course of psychosocial evolution has been erratic, wasteful, and full of imperfection. It is easy to take a pessimistic view of man's history in general, and of his present situation in particular, where force and fear have become magnified on a gigantic scale.

Hopeful Process

But when we survey the process as a whole, it looks more hopeful. During its course, there has been progress. Progress has always been the result of the discovery, dissemination, or application of human knowledge, and human knowledge has shown a cumulative increase. Furthermore, the erratic course of past psychosocial evolution was largely due to man as a species being divided against himself, and not having discovered any single overriding aim.

There is now a dramatic change in process. The human world has become inextricably interlocked with itself; the separate parts of the psychosocial process are being forced to converge toward some sort of organized unity. We are at last able and indeed compelled to think in terms of a single aim for mankind, while our increasing knowledge is enabling us to define our aim in relation to reality instead of in terms of wish-fulfillment: our knowledge of our imperfections and limitations is helping to define the possibilities of our improvement.

This marks a critical point in history. We have discovered psychosocial evolution as a complex but natural phenomenon, to be explored and controlled like other natural phenomena. Up till now, it has operated in erratic and often undesirable fashion, with self-contradictory aims. We now see that it could be transformed into an orderly mechanism for securing desirable results.

The idea of greater fulfillment for all mankind could become a powerful motive force, capable of influencing the direction of future evolution, and of overriding the more obvious motives of immediate personal or national self-interest. But it can only do so if it and its implications are properly understood, and made comprehensible to the bulk of men, all over the world. For this we need not only an extension of science but a reorientation of education; not only more knowledge, but also a better expression and a wider dissemination of ideas.

We must not imagine that the fuller realization of possibilities will be accomplished without effort, conflict, or suffering. This is inherent in the nature of man and of the psychosocial process: but so is hope.

The individual human brain and mind is the most complicated and highly organized piece of machinery that has ever existed on this earth. So-called electronic brains can perform extraordinary tasks with superhuman rapidity: but they have to be given their instructions by men. The human organism can give instructions to itself; and can perform tasks outside the range of any inanimate machine. Though at the outset it is a feeble instrument equipped with conflicting tendencies, it can in the course of its development achieve a high degree of integration and performance.

How Shall We Use It?

It is up to us to make the best use of this marvellous piece of living machinery. Instead of taking it for granted, or ignorantly abusing it, we must cherish it, try to understand its development, and explore its capacities.

The collective human organism, embodied in the psychosocial process, is an equally extraordinary piece of machinery. It is the mechanism for realizing human destiny. It can discover new aims for itself, and devise new methods for realizing them; but it is still primitive and inefficient. It is up to us to improve it, as we have improved our inanimate machines. Our ignorance about its potentialities is profound; therefore our immediate task is to understand the first principles of its operation, and think out their consequences.

Thus the new vision we owe to science is one of real though tempered optimism. It gives us a measure of significance and rational hope in a world which appeared irrational and meaningless. It shows us man's place and role in the universe. He is the earth's reservoir of evolutionary possibility; the servant of evolution, but at the same time its youthful master. His destiny is to pursue greater fulfillment through a better ordering of the psychosocial process. That is his extraordinary privilege, and also his supreme duty.

Our new vision assures us that human life could gradually be transformed from a competitive struggle against blind fate into a great collective enterprise, consciously undertaken. We see that enterprise as one for greater fulfillment through the better realization of human possibilities.

It is for us to accept this new revelation given us by science, examine it, and explore all its implications, secure in the knowledge that ideas help to determine events, that more understanding leads to more appropriate action, that scientific truth is an indispensable weapon against stupidity and wickedness and the other enemies of fulfillment, and true vision the parent of progress.

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